MENTAL PHYSIOLOGY

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ESPECIALLY IN ITS RELATIONS TO

MENTAL DISORDERS

BY

THEO. B. HYSLOP, M.D.

LECTURER ON MENTAL DISEASES TO ST. MARY'S HOSPITAL MEDICAL SCHOOL,
ASSISTANT PHYSICIAN TO BETHLEM ROYAL HOSPITAL,
FORMERLY ASSISTANT MEDICAL OFFICER, ROYAL ALBERT ASYLUM FOR IDIOTS AND IMBECILES, LANCASTER,
DEPUTY-PATHOLOGIST AND ASSISTANT MEDICAL OFFICER, WEST RIDING ASYLUM, WAKEFIELD

"Non enim tam auctoritatis in disputando, quam rationis momenta quærenda sunt"
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TO

GEORGE H. SAVAGE, Esq., M.D., F.R.C.P.,

IN GRATEFUL ACKNOWLEDGMENT OF MANY ACTS OF KINDNESS

AND ENCOURAGEMENT, AND AS A MARK OF

APPRECIATION OF HIS TEACHINGS AND WIDENESS OF VIEW,

THIS BOOK

Is Dedicated

BY HIS FRIEND AND PUPIL,

THE AUTHOR.

PREFACE.

In the following pages an attempt is made to bring together some of the more prominent phenomena of the brain and of the mind, both in their normal and morbid aspects. To the metaphysical and philosophical bearings of the various assumptions involved in such an attempt, little or no prominence is given. In philosophy we are free to choose between a natural dualism and a hypothetical realism, or we may be materialists or idealists: in empirical psychology or physiology it would, presumably, be a work of supererogation to enter at length upon questions of epistemology or metaphysics.

In discussing the relations of the outer world as the mind knows it, the assumption that complex mental experience is only an inner representative of a genuine externality has been adhered to, without entering into any philosophical account of the method whereby the existence of the whole outer world is inferred through its representative images.

In dealing with many hypotheses which have been given to account for mental events in physical terms, objection has been taken throughout; and little or no attempt has been made to speculate as to the ultimate nature or quality of nervous or mental events.

In an elementary work of this description it is obvious, that an exhaustive account of the anatomy, physiology, and pathology of the brain would defeat its own object—viz., conciseness. The author has, therefore, merely sought to bring into apposition, as it were, some of the more important cerebral and mental facts, and no pretence has been made to furnish the student with an elaborate treatise upon any department of the subject-matter.

In the preparation of the work the author has much pleasure in acknowledging, with thanks, the valuable assistance and advice of his friend, Mr. W. A. Haigh. His thanks are also due to his friends, Mr. H. F. Harding, for revisal of the proof-sheets, and Dr. Maurice Craig, for the preparation of the index.

T. B. H.

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MENTAL PHYSIOLOGY.

INTRODUCTION.

The Value of Hypotheses—Boundaries of our Subject—Psychology a . Science—The Relation of Psycho-physiology to the General Stud of Mind—Mind Relative or Absolute?—Definition of Mental Phy siology, Mental Pathology, Physiological Psychology—Relations of Mind to Body—Empirical Psychology—Speculative Psychology—Spiritual Theories—Occasionalists—Theory of Pre-established Harmony — Animists — Associationists — Dualism — Monism — Automatism—Material Monadism.

In a system of philosophy every affirmation is liable to have its truth determined by a variety of tests. These tests must not only be in accordance with our manifold conditions of knowledge, but they must also be proportionately varied. The student would do well to proceed according to the admirable advice of Goethe :—"Let the inquirer consider himself as one summoned to sit on a jury. His part is merely to see how far the indictment is borne out by the evidence." Truth and distinctness of object are of primary importance. The multitude of facts at our disposal must be carefully sifted. We must discriminate between the essential and the accessory, the important and the insignificant, and when all the arguments in our scientific investigation are exhausted, we must not, by the construction of hypothetical fables, falsify many existing truths by fictions of the imagination. In the domain of psychology some inquirers search for novelty rather than truth, and, with the pretence of solving doubts, entertain us with hypotheses which are not only fanciful but absurd.* It is incumbent upon us, therefore, as a duty which we owe to science, to be most scrupulous and cautious in stating our individual opinions. Rather let us remain in a condition of uncertainty than propound doctrines which not only falsify existing truths, but even block the way to further research.

If we look at the boundaries of our subject, on the one side we have the domains of metaphysics and ethics, whilst on the other, that of the human organism as viewed by the physiologist. We must endeavour to confine ourselves more particularly to our own portion of the study of philosophy, and with regard to the special requirements of the physician, abstract from the study of a rational or empirical psychology, only so much as is essential to our purpose. In *speculative psychology* little or no account is taken of the relations of the mind and body; the mind is regarded as a conscious being that perceives, thinks, imagines, remembers, feels, and wills; and in regard to the infinite variety of relations that exists between the mind and the varied functions of the brain, no attempt is made to reduce them under general laws of cause and effect. The attempt to reduce them under such laws brings us to an empirical psychology, or method of thought resembling the natural sciences, and of which psychology and physiology form, of course, the component parts.

The position of our own particular sciences would be as follows:—

(1) Physiology.
- (*a*) Descriptive.
- (*b*) Experimental.
- (*c*) Speculative.

(2) Psychology.
- (*a*) Descriptive.
- (*b*) Experimental.
- (*c*) Speculative.

* Those hypotheses which make the results of physiology involve subjective data, and thereby raise metaphysical questions as to the substantive or dynamic nature of mind, must be carefully distinguished from what we can with fairness accept as postulates pertaining to the departments of physiology and psychology.

The relation of physiological psychology to the general study of mind is shown in the following diagram by Baldwin* :—

- PSYCHOLOGY
  - Empirical (Inductive)
    - Descriptive (Analytic)
      - Internal
      - External
      - Cause to effect
    - Experimental
      - External
        - Physiological
          - Neuro-psychology
          - Psycho-physics
          - Psychometry.
      - Internal
        - Hypnotism
        - Dreams
        - Insanity
        - Mental pathology.
      - Cause to effect
  - Rational (Deductive)

In our account of the relation of psychology to physiology we are absolutely unable to avoid some metaphysical questions; for, any discussion upon the nature of the mind involves a rational or deductive element, as much as does also any discussion upon the ultimate nature of the physical elements of the brain. The attempt to analyse physiological data has resulted hitherto in vague conceptions as to inter-atomic motions, and we are taught to imagine oscillatory motion of the atoms of the substances that combine.† Similarly, the attempt to analyse psychological data has involved vague conceptions as to inter-psychical motions, and we are taught to imagine that ideas derive their component parts from this or that structural equivalent. How far these hypotheses are supported we shall make it our particular object to inquire, and in our employment of the term "conception" (as applied to such hypotheses) we do not mean thereby that we are able to form a definite picture of what takes place. We use the term in its widest sense, and failure to conceive many of the accepted hypotheses, must be taken as failure to conceive how the requirements of one series of events are met by the events of the other series.

In the study of medicine there is a preponderance of

* Baldwin, "Handbook of Psychology," p. 31.

† Gower, "Dynamics of Life," p. 10.

the somatic element, and little or no regard is paid to the psychical element. According to Hartmann the reason of this neglect is to be found in the fact, that philosophers by profession are not necessarily physiologists, and, on the other hand, that physiologists are seldom enough of philosophers to handle their subject successfully. In the following pages everything that can tend to effect this union of characters for medical purposes is part of our object. Later we shall see that there are two ways of treating the subject of our investigation—1st, The analytical, which induces the particular from the unity of the scientific idea. 2ndly, The synthetical, which takes particulars as the starting point, and aims at reaching scientific unity.

The question may be asked: Is there a science of psychology? Our reply must depend upon the meaning in its *intension* of the word psychology. If it implies a science which deals with mental phenomena as they exist, implying also that the mental phenomena have physical correlatives, but, at the same time, taking no account of their possible explanation, then our answer would be in the affirmative, and our position would be as secure as that of any other science. Should, however, we restrict our meaning so as to regard the mind as absolute, then we pass from the region of science and imply the existence of an entity about which we can only speculate. Unfortunately, the boundaries of mental physiology extend into two spheres. In the one we have conflicting philosophical doctrines, many of which, however, may, with advantage, be consigned to oblivion; whilst, in the other we have that which is empirical, and even more full of conflicting and often superfluous opinions. In the former department the knowledge and examination of some of the philosophical doctrines are, to a great extent, indispensable to us; whilst in the latter our knowledge is so incomplete that, in order to attain to some degree of precision and clearness, we cannot consider a knowledge of previous opinions superfluous. If we regard our science, however, as an empirical one, we may with great advantage be allowed to be ignorant of what is useless; and we do not feel bound to transmit all that is believed to have been known.

Every system of philosophy is subject to modifications, and, moreover, within limits, will eternally be so. To recognise, and to be conscious of these limits, is another important part of our task. By the frank recognition of what cannot be known, much time is spared, and much error avoided, and it is only when we are sufficiently clear about the impossibility of explaining many things that we shall be able to avoid vain attempts to estimate or elucidate phenomena, the explanation of which is unknowable for us, and hopelessly beyond our power.

In order that we may have a firm foundation and a definite terminology, we must take every step with security, and in so doing we may be able to make some advance in our knowledge of the physiology of mental operations. We shall, therefore, after making an attempt to determine the facts and notions from which we have to proceed, begin with the most simple operations and gradually advance to the more complex.

Are we to regard the term "mind" as relative or absolute? If we are to regard it as relative in meaning, it would denote an object which cannot be thought of without reference to some other object, or as part of a larger whole—*i.e.*, just as the term "father" cannot be thought of but in relation to "child." If this be our position, the term mind cannot be thought of apart from body, and we are compelled to view "mind" as relative, and "body" as its correlative. Such a distinction is no doubt convenient from a logical point of view, but from a scientific point of view it is somewhat different—*i.e.*, the terms tree, sun, earth may be used as absolute terms in logic (*i.e.*, having no apparent relation to anything else), but in science it would be impossible to prove their absolute independence. From a scientific standpoint, therefore, we are not justified in regarding mind as absolute, but, as with every other phenomenon of nature, relative.

If we accept the term "mind" as relative, however, we do not thereby extend its connotation so far as to imply a causal relation, or even a possible explanation of its correlation. In fact, we must define the term "mind" as relative only so far as we appreciate it in its relation to the body, without in any way implying an explanation of the nature of the relation. As the naturalist knows and applies electro-magnetism in its relations, without comprehending its essence; as the astronomer calculates the movements of the planets, without knowing their absolute relativity: so we can duly appreciate spirit and matter in their relations to each other as body and mind, without being able to explain their actual nature or their deepest relations.

Let us now, therefore, understand what is meant by **mental physiology.** As defined by Hack Tuke,* mental physiology is one division of the great department of physiology. It seeks to discover the bodily organisation with which mental operations are connected. Seeing that the brain is admitted to be the organ of mind, it endeavours to trace their correlations in detail. Unconscious no less than conscious mind falls within its range. The student of mental physiology makes the functions of the nervous system his especial object of study, employing for this end all the objects within his reach. He endeavours to discover the laws by which mental operations are governed, and to classify their phenomena; but he is not concerned with speculative metaphysics in the usual sense of the term. Mental physiology, however, embraces such modern psychological methods of research, as are instituted to determine the relation between the action of external stimuli on the sensory end organs, and the resulting sensation or motion, as well as the reaction time of mental phenomena generally. Ladd defines the expression "physiological psychology" as the science of the phenomena of human consciousness in their relations to the structure and the functions of a nervous system. Carpenter, in his "Mental Physiology," has gone a step further, and, by the consideration of mental pathology, has attempted to throw additional light upon the subject.

The term **"mental pathology"** requires some explanation. Putting aside for the moment the question of *dependence* of the mind upon the brain, we are compelled to admit that, just as we are ignorant as to the manner in which physical states cause mental states, so are we absolutely without any knowledge as to the methods by which morbid physical factors give rise to morbid psychical events. By this we mean, that any complete explanation of the ultimate *causal* connection between the morbid material factors and the morbid mental manifestations is impossible for us. Therefore, we must of

* "Dictionary of Psychological Medicine," p. 804.

necessity view the pathology of a mental state from a psychical, as well as from a physical, standpoint—*i.e.*, until we can associate the simplest mental fact with its corresponding physical fact, we cannot hope to solve in physical terms the most simple morbid train of thought as seen in the insane. Mental pathology must, accordingly, be viewed from two sides —namely, its psychological, and its physiological side; and our hope is that we may bring the two series of phenomena, as it were, "face to face," without in any way rendering our position insecure by unnecessary hypotheses as to ultimate cause and effect.

The student will now recognise how limited must be our explanation of mental and physiological facts, and that no amount of accuracy in detail, or any mere enumeration of a series of phenomena, will explain the nature of another series. In pursuing these inquiries, much difficulty will be experienced in our efforts to " unlearn the errors of the crowd, and the pretended wisdom of the schools." Scientific statements, with the sanction of scholastic authority, will prove more dangerous to us than controversial discussions on points purely speculative, and in this relation we must appreciate that—until the proximal causal connection between the world of immaterial and material things is explained—when we depart from the consideration of the facts contained within each, and attempt to speculate upon their nature and cause, we wander at once from the path of scientific inquiry into that of conjecture, and find ourselves contemplating problems, the truths of which are far beyond our reach. The psychologist and physiologist, each from his own point of view, may equally be justified in saying such speculations ought to be entirely banished from their practical investigations, as not only useless and improbable, but as beyond the reach of their faculties, and, therefore, contrary to the first principles of scientific investigation. Our own object, I apprehend, should be simply to investigate the facts in regard to both mind and brain, and not so to misconceive the first principles of scientific inquiry as to attempt to construct a philosophy of cause and effect by unsound reasoning and logical absurdities.

Of all the important principles which are commonly called first truths, the most important to us is to be found in the answer to the question—"What is life?" A rigid definition of life is impossible. We can only view it on the physical side as being simply a tendency exhibited by certain forms of matter, under certain conditions, to pass through a series of changes in a more or less definite and determinate sequence. All definitions of the phenomenon of life are objectionable, and really mean nothing, inasmuch as they are merely enumerations of the phenomena observed, which indicate the existence of that called life. Were we in a position to answer this question satisfactorily, we might then ask, What is mind? and how can we explain it? Our answer is, and must ever be, We don't know. And we never can know. In the history of psychology many attempts have been made to solve this problem. One source of fallacy has arisen, not infrequently in the actual reasonings of so-called materialists and spiritualists, whereby, in disproving a doctrine, they have fallen into the sophism of assuming the opposite doctrine to be true, thus making the truthfulness of that doctrine dependent upon the unsoundness of that which is opposed to it.

In the light of existing knowledge, therefore, we are compelled to approach the subject by two roads. Physiologists and psychologists must perforce study their respective subjects, to a certain extent, apart and in their entireties. The fundamental disparity of physical and psychical activities renders the explanation of the one impossible from the study of the other; and, moreover, at the very outset, we must fully recognise, that in naming the nervous accompaniments, or physical conditions of mental phenomena, we do not fully account for them, no matter how faithfully detailed the description of such accompaniments may be. Such mere enumerations do not in the least degree aid us in the solution of their causal connections. This does not, however, interfere with the primary conception that there is concomitance and co-variation of physical and psychical processes. Hitherto, the attempts to prove causal relations between psychical events and physical processes have proved useless. The two are plainly connected in time, but our recognition that the two conditions have time associations in no way explains their ultimate or causal connection. Professor James says,* "The ultimate of ultimate problems, in the study of the relations of thought and brain, is, to understand why and how such disparate things are connected at all. But before that problem is solved, it must at least be ascertained and reduced to the lowest terms as to which mental fact and which cerebral fact are, so to speak, in immediate juxtaposition. We must find the minimal mental fact whose being reposes directly on a brain fact; and we must similarly find the minimal brain-event which will have a mental counterpart at all. Between the mental and the physical minima thus found there will be an immediate relation, the expression of which, if we had it, would be the elementary psycho-physic law."

A statement of all the relations which exist between mental phenomena and the changes with respect to chemical constitution, structural form, and physiological function, which take place in the molecules of the cerebral areas, would constitute the foundation for an empirical science of the connection of body and mind.

Tyndall† says, "There is no fusion possible between the two classes of facts." We can trace the development of a nervous system, and correlate with it the parallel phenomena of sensation and thought; we see with undoubting certainty that they go hand in hand, but we cannot comprehend the connection between them." Again,‡ he says, "The passage from the physics of the brain to the corresponding facts of consciousness is unthinkable. Granted that a definite thought and a definite molecular action in the brain occur simultaneously, we do not possess the intellectual organ, nor apparently any rudiment of the organ, which would enable us to pass, by a process of reasoning, from one to the other." Spencer§ holds that a unit of feeling has nothing in common with a unit of motion, and that this becomes more than ever manifest when we bring the two into juxtaposition.

Let us now glance at the so-called science of **physiological psychology** which constitutes a part of our empirical

* "Principles of Psychology," p. 177.
† "Nature," August 20, 1874, p. 318.
‡ "Fragments of Science," 5th edit., p. 420.
§ "Principles of Psychology," p. 62.

psychology. (1) There are, without doubt, certain psychical phenomena or processes that do not occur independently of certain material phenomena and processes, and which are not alien to the latter, but stand in obvious correlation to them, and *vice versâ*; and (2) there are psychical processes for which no corresponding physiological processes in the brain are conceivable, and we are not yet in a position to assert that material processes do accompany all psychical processes. Physiological psychology deals exclusively with those psychical phenomena to which concomitant physiological processes in the brain correspond, and is chiefly concerned with variations which occur in the quality, intensity, combination, and time-order of the states of consciousness, as dependent upon the varying amounts and order of different modes of physical energy as applied to the end organs of sense.* According to Ladd, physiological psychology is in a fair way to make out, that all psychical activity has, as its concomitant, some mode of physical action, and that mental life more particularly coincides with the central portion of the nervous series; namely, the cerebral process. "Mental life is thus a chain of events parallel to another chain of physical events." The question as to the mental dependence or causal connections of these two series of phenomena has not been solved by scientific methods. We are not in a position to regard the psychical action as the result of sensory stimulation in the first stage, nor as the result of the muscular action in the final stage.

Physiologists look upon the series of nervous processes as complete and satisfactory in themselves, having consciousness as their accompaniment or collateral result. Psychologists, on the other hand, uphold the view that many psychical processes cannot be demonstrated as having any physical correlative. Spencer takes mind in the midst of all its concrete relations, and says that the essence of mental life and bodily life are one—namely, the adjustment of inner to outer relations. "The mind inhabits an environment which acts on it, and on which it in turn reacts." Physiologists say, "No psychosis without neurosis"—and it is to the study of the exact relation between the dispositions of the architecture of the cerebral substance,

* Ladd, "Physiological Psychology," p. 633.

aided by physiological experiments and pathological anatomy, that they hope to become more closely acquainted with the principles upon which this mechanism operates—infer function from structure, regarding the former as the natural outcome of the latter. In reply to this, Professor James points out that, no matter how numerous and delicately differentiated the train of ideas may be, the train of brain events that runs alongside of it must, in both respects, be exactly its match, and we must postulate a neural machinery that offers a living counterpart for every shading, however fine, of the history of its owner's mind. Whatever degree of complication the latter may reach, the complication of the machinery must be quite as extreme, otherwise we should have to admit that there may be mental events to which no brain events correspond.

In accepting the theory of *psycho-physical parallelism*, we limit the parallelism to mental life, and the activities of the nerve structure of the organic world. We stop at conjectures, which make mind co-extensive with matter, or which make the parallelism absolute, and assign a subjective side to every atom of cosmic dust. We accept as fundamental, the psycho-physical parallelism, the conservation of energy, the indispensability of introspection, and the utility of the experimental method. How far we are warranted in assuming that the entire qualitative content of consciousness is explicable by the association of sensational elements in conformity with physical laws, we shall venture to inquire. We shall avoid following the psychology that fails to recognise the limitation on the study of mind through matter. The application of the parallelism beyond consciousness belongs to metaphysics and epistemology. We merely postulate the co-existence in time, between the events, the physical and mental series.

The tendency of many authors, who seek to prove a parallelism in the evolution of life and mind, is to start the parallelism somewhere only when the biological evolution has attained a certain degree of complexity; others, again, attempt to drop the parallelism when a further degree of complexity has been attained; they then assign to the mind or body powers which on analysis are unwarrantable. If the parallelism is to be complete, the phenomena of human life and mind must be traced as correlatives from the very beginning and to the very end. There is no period in the evolution of the organism when mind can be said to appear.

From time to time, we shall have occasion to criticise the principles of physiologists in regard to the complexity of neural action, and we shall see that mere complexity of arrangement in the refined mechanism of the brain may serve to demonstrate the ways and means of physiological activities; but these principles afford us no solution of any of the subjective attributes of the mind. We grant the existence of dynamical functions, and we are forced to accept many of the hypotheses advanced to elucidate the occurrence of activities in a rational and orderly sequence; but no arguments hitherto adduced will allow us to grant that consciousness is a mere inert spectator of physiological processes.

We shall have occasion to criticise the general law that "no mental modification ever occurs which is not accompanied or followed by a bodily change," and we shall take account, not only of the conditions antecedent to mental states, but also of the resultant consequences of such mental states—*i.e.*, a certain amount of brain physiology must be presupposed or included in psychology.

Physiological psychology is defined as "the science which investigates the correlations that exist between the structure and functions of the human nervous mechanism and the phenomena of consciousness, and which derives therefrom conclusions as to the laws and nature of the mind."* We do not, however, infer that the science, as such, seeks as its object to form conclusions as to the nature of one series of phenomena from the study of those of the other—*i.e.*, the study of the laws which govern matter and *their concomitance with mental acts*, would only form part of the basis of the study of mind. Our task is now one of extreme difficulty. Let us compare the inanimate cerebral mass in all its structural complexity, to the earth with its geological strata and substrata, and for illustration let us surround them with the mind and the atmosphere respectively. Putting aside the question of their several causal connections and mutual dependence, we

* Ladd, "Physiological Psychology," p. 4.

propose to elucidate the phenomena of the one by the study of the other. Geologists divide the globe into a certain number of geographical regions or "zoological provinces," each of which is characterised by the occurrence in it of certain associated forms of animal life. In the vertical or bathymetrical distribution of animals we find that, as a rule, each species has its own definite bathymetrical zone, and it is by generalising from a large number of such facts that we are able to lay down and name certain definite zones. In addition, geologists and zoologists have to investigate the conditions and nature of animal life during past epochs in the history of the world. They are enabled to estimate, with a certain degree of accuracy, how one animal differs from another, morphologically in the fundamental points of its structure, and thereby infer a physiological specialisation of function from the grade of its organisation, or they are able to formulate doctrines of evolution. Similarly the physiologist may study the complex surface of the brain, differentiating it into functional provinces, each having its own definite zone, and he may infer a specialisation of function from the distributive development of its component parts. Further, on the one hand, the geologist may estimate with accuracy the correlation of certain types of structure with certain climatic or atmospheric phenomena; whilst the physiologist attributes *functions* to certain nervous elements having mental phenomena as their correlatives. Is it possible, however, for the former to fully estimate the laws which govern the atmosphere, solely from the study of the earth's crust, and the mere estimation of concomitant atmospheric conditions? or, is it possible for the latter to estimate the nature of mind, and the laws which govern it, solely from the study of the structure of the nervous mechanism, and the enumeration of collateral series of mental activities? Until we are able to formulate one general law as to cause and effect between material and immaterial phenomena we must of necessity approach the subject from its two totally different aspects, and the closest attention to psychical *laws* (considered as such) is as indispensable to our success as the minutest investigation of structural detail. Any real advance is to be made only by the study of the laws of both series of events. Physical analysis has taught us nothing as yet about subjective states; whilst subjective analysis has been just as futile with regard to objective states. Physiological psychology has as its ultimate task the apposition, and comparison of objective and subjective states. It seeks to discover the laws which bind together processes, which in their essence have no knowable community with each other.

A material bond may be conceived in connection with matter, a non-material in connection with mind, but the bridge between the two must be constructed of one or the other, or, perchance, as suggested by one eminent writer, a substance intermediate between mind and matter, which partakes of the nature of both without being exclusively either. To this Mercier aptly remarks, "Imagine a thing which is partly an iron bar and partly a smell of paint without being exclusively either!" The connection is no less real, however, because it is inexplicable, and no one doubts that causal connections do exist although they cannot be explained. If we look at the position, as viewed by Ziehen, all psychical processes for which there is no conceivable corresponding physiological process in the brain are to be ignored. He admits, however, that as a consequence, we do not obtain sufficient knowledge unless, in addition, we investigate certain psychical phenomena as purely psychical, but nevertheless being always aware of the possibility of some concomitant cerebral process.

Empirical psychology is, therefore, to be studied under two heads. (1) Psychical processes not contingent, or demonstrably dependent, upon cerebral processes, termed by some transcendental psychology. (2) Psychical processes concomitant with, or apparently dependent upon, cerebral processes, termed the science of physiological psychology, metrical physiological psychology, or psycho-physics. Later, when we discuss mind and nervous conditions in their several relationships to one another, attention will be given to the various psychological methods of research, and the psychical effects of varying conditions of nerve organs will be dealt with in detail. Account will also be taken of the question, as to whether the activity of all parts of the brain is directly concerned with conscious life, or only that of certain of its structures; or whether the organ of mind includes other centres as well as brain centres; and we shall have recourse to the results obtained by artificial experimentation, by which definite external stimuli have been employed, the subjective effects of which have been objectively noted and registered; and to the pathological aspects of cerebral diseases having mental correlations.

Before entering, however, upon the questions as to the interaction of mind and brain, let us review, briefly, some of the hypotheses which have been derived from speculation upon the philosophical, ethical, and religious aspects of their causal connections.

The **spiritual** theory holds, that the mind is a soul distinct in its nature and mode of activity from material things, and, in accordance with the Cartesian philosophy, the body and soul cannot act upon each other because of the essential difference between the two. By the *Occasionalists*, body and mind are regarded as having no causal relations—*i.e.*, neither really acts on the other. An event of a definite kind happens in the bodily realm, a corresponding event of its own definite kind happens in the domain of consciousness, and *vice versâ*. They are connected causally through a common ground by God. A further development is to be found in the theory of *pre-established harmony*, by which God has eternally predestined the entire succession of events in the world, down to every minutest detail.* *Animists* (*animo*, I give life to) adopt the Stahlian theory of the soul, and regard it as the vital principle. The term "animism" is now, however, ordinarily used to express the general doctrine of spiritual agency in the operations of nature.† Mercier‡ regards the whole doctrine of so-called spiritualism as a survival, in slightly altered form, of the old superstition of demoniacal possession. Commenting upon such terms and phrases as "psychomotor-centres," "ideomotor processes," "sensation changing into movement," he says, "Commonest and worst of all is the prevalent opinion, expressed or implied, that above the material part of the brain, somewhere in the skull cavity, there sits a little deity who

* Ladd, "Physiological Psychology," p. 650.

† Tuke, "Dictionary of Psych. Med.," p. 94.

‡ "Sanity and Insanity," p. 48.

sends his orders out this way and that, and by some mysterious but easy process produces all the movements of the body. He plays on the centres of the brain as a performer plays on the key-board of the piano, and produces just such combinations and successions of movements as he pleases, untrammelled by natural laws. This being is variously named, according to the predilections of the writer, some calling him the Will, others the Ego, others again Conscious Personality, others the Soul; while yet others split him up into several beings, and with the natural tendency of anthropomorphism, not only let them make common cause against their unfortunate servant—the body—but set them fighting among themselves."

The effort to evade the question of the freedom of the will arises, in most instances, from the absence of any definite concept of the nature of the subject under debate. The dilemma is, to a certain extent, extra-psychological.* Psychology, however, can deal with the problem through analysis of the activity and selective character of choice. Were we able to eliminate motivation from our consideration, then, also, might we regard determination as external and not internal. The assumption that mechanical law or determination by extraneous influences is the only conceivable type of orderly activity is natural; the fact that, as yet, we fail to conceive of any universal law of choice, is no argument that the former assumption is the only solution. We find ourselves at issue with the psychologists, who regard ideo-motor action as the type of all volition, and we fail to reduce all choice to immediacy without deliberation. Those psychologists who deny their own agencies in volition are fatalists, and base their conclusions upon false ideas of the relation between mechanical causation and self-determined activity. The purpose of modern physiological psychology is to try to demonstrate the relation of the mind to the brain, and, at the hands of some inquirers, the problem is solved as physiological fatalism. Others conceive themselves as mere spectators of effects determined by whatever their absolute may chance to be. The logical import of the controversies would lead us to conclude that self-determination cannot be

* Prof. A. T. Ormond, "Freedom and Psycho-Genesis"—"Psych. Review," May, 1894.

reduced to mechanical laws. The various laws which predetermine (through heredity and environment) the physiological and psychological individuality give no solution of the self-determination of choice.*

The **association** school, of Herbart in Germany, and of Hume, Mills, and Bain, in England, has constructed a psychology in which the soul or *ego* of the individual is no longer viewed as the pre-existing source of the representations, but rather as their last and most complicated result. Its disciples endeavour to show how such things as perceptions, emotions, volitions, etc., may be engendered in an individual by the cohesions, repulsions, and forms of succession of discrete "ideas" and without the aid of a soul. Materialists seek to reduce organic life to the effect of mechanical arrangements, and they regard mind as an effluence from, or product of, the activity of this material substratum. They regard the constitution and activities of molecules, as determined by the interaction of the ultimate atoms which comprise them, under the law of the conservation and correlation of physical energy. Whenever a certain constitution and consequent modes of activity are brought about in the molecules, under this general law, then it is of their own comprehensible nature to exhibit, in addition to the various forms of motion known as nerve commotion, another class of co-existing phenomena, called mental phenomena.†

Later, we shall see that the arguments of even the most advanced materialists, who regard thought as the effect, or result of cerebral movement, are insufficient to afford the slightest explanation of any subjective mental state. "The whole circle of consciousness is," says Baldwin, "an added fact to that of movement." Many of the materialists ridicule the idea of an immaterial mind acting upon a material body; but they do not hesitate to affirm that a material body can act on an immaterial mind.

If we look more closely at the physical laws of "correlation of energy" we at once see that they afford us no help in the

* See Baldwin, "Handbook of Psychology," vol. ii. pp. 352—376; Hodgson, "Free Will: an Analysis"—"Mind," April, 1891.

† Ladd, "Physiological Psychology," p. 654.

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solution of the causal relations of mind and matter; for we must classify all forms of physical energy according to their quality, nature, degree, and amount of their motion; and we are unable to demonstrate or define states of consciousness in the same manner as modes or amounts of motion, and, in consequence, we cannot attempt a strict mathematical correlation between physical motion and such states of consciousness. In the endeavour to bridge the gap between the molecular energy of organic material and that of the mode of activity of mind, the various mathematical formulæ, under the laws of conservation and correlation of energy, have been unwarrantably extended in their application. Further, as Ladd puts it, "Psychology teaches that the world of mental objects—the only world of immediate experiences—is built up by the synthetic activity of mind; it calls upon the physicist to remember that he has no other way of reaching these atoms and of discovering the laws of their relations except by the path of mental activity; and it reminds him that this activity cannot escape the control of mental law."

In addition to the spiritualistic theory that so-called inanimate objects are vitalised by a principle which involves purpose or end, and the materialistic view of mind as the result of an activity of complex physical forces, we have combinations which aim at giving equal substantive reality and power, both to the spiritual and to the material.

In the theory of **dualism** we find a combination of the two substances, which are viewed as existing side by side, but as exerting no influence the one on the other, the appearance of interaction being due to Divine arrangement. The molecules of the brain act, dynamically, according to their own constitution and modes of arrangement. The mind, on the other hand, as a real entity of another order, has the various states of consciousness as its acts; and, according to the more recent doctrines of dualism, the two series of phenomena are correlated. The nature of the correlation is unknown, but it is assumed that the mind and brain act in view of each other: the action of the one accounting for the action of the other in some unexplainable and unknowable way. There are three forms of dualism—viz., (1) The metaphysical, which takes account of mind and matter; (2) The philosophical, which takes account of the body and the soul; and (3) The ethical, which concerns itself with good and evil.

The desire to connect the two metaphysically has given rise to the doctrine of **monism,** according to which, one reality has two aspects—*i.e.*, material phenomena and mental phenomena are related as two attributes of the same substance. This implies the existence of a substance composed of two utterly incomparable series of phenomena, and to regard this substance in the terms of either series must result necessarily in arguments from the point of view of the spiritualist or the materialist. Wundt recognises three types of theory: *Materialism*, *Spiritualism*, and *Animism*, the former two each having a dualistic as well as a monistic form. Bain, on the other hand, forms two main groups—viz., Those which adopt two substances, and those which assume but one.

Let us now venture to look at the subject for ourselves and ask ourselves, Is there any test whereby we can distinguish between a physical or physiological and an intelligent act? Many hold the view that the pursuance of future ends and the choice of means for their attainment are the mark and criterion of the presence of mentality, and that no actions but such as are done for an end and show a choice of means can be called intelligent. Professor James says: "If we find ourselves unable to banish the impression that there is a realm of final purposes, that we exist for something, we place intelligence at the heart of it and have a religion. If, on the contrary, in surveying its irremediable flux,* we can think of the present only as so much mere mechanical sprouting from the past, occurring with no reference to the future, we are atheists and materialists." The same author regards consciousness as having a causal efficacy, and as being at all times primarily a selecting agency. "Every actually existing consciousness seems to be a *fighter for ends*, of which many, but for its presence, would not be ends at all." In fact, consciousness directs its own machinery. "The spiritualist may believe in the soul if he will, the pessimist may say that Nature, in her unfathomable designs, has mixed us of clay and flame, of

* "Irremediable flux" is essentially pessimistic.

brain and mind, that the two things hang indubitably together and determine each other's being, but how or why, no mortal may ever know." Undoubtedly, the nutrition of the tissues, the circulation of the blood, and the secretion of different kinds of fluids are dependent, to a great extent, upon the states of the mind; and, later, when we come to study the influence of the mind upon the body, we shall find that, if, with sluggish and abnormal digestion, we have mental depression, it is equally true that an attack of melancholia will retard and pervert the processes of digestion; and, similarly, emotional conditions, stress or strain, may impair the cerebral mechanism and its functions.

In opposition to these more or less spiritualistic views we have the authority of Professor Huxley, who says that in animals, their volition, if they have any, is an emotion *indicative* of physical changes, and not a cause of such changes. We are, therefore, regarded as *conscious automata.* "Our mental conditions are simply the symbols in consciousness of the changes which take place automatically in the organism. In men, as in brutes, there is no proof that any state of consciousness is the cause of change in the motion of the matter of the organism." We can also add, it is not possible to form any conception as to how any state of consciousness can affect the cerebral molecules, and, moreover, we never shall be able to surmount or explain this difficulty; but our inability to explain such action does not negative its possibility. The view, however, that the feeling we call volition is not the cause of a voluntary act, but the symbol of that state of the brain which is the immediate cause of that act, is open to any number of arguments. Professor Clifford states, dogmatically, that the only thing which influences matter is the position or motion of surrounding matter, and "if anyone says the will influences matter, the statement is nonsense." "Were this the case," remarks Professor James, "the mind's history would run alongside the body history of each man, and each point in the one would correspond to, but not react upon, a point in the other," and we agree with him that, "in the present state of psychology to urge the automaton theory upon us on purely *à priori* or *quasi*-metaphysical grounds is an unwarrantable impertinence." Spiritualists and materialists are free to argue from their respective standpoints; while we, as unbiased spectators, are also free to state that we can as readily imagine an immaterial psychical state influencing a material bodily state, as we can a bodily state affecting a mental state; and this although the two series of activities have no community with each other.

The material monad theory, or the theory of "*polyzoism*" or "*multiple monadism*," as upheld by Leibnitz, Herbart, and Lotze, is as follows:—"Every brain-cell has its own individual consciousness, which no other cell knows anything about, all individual consciousness being 'ejective' to each other. There is, however, among the cells one central or pontifical one to which our consciousness is attached. But the events of all the other cells physically influence this arch-cell; and through producing their joint effects on it, these other cells may be said to 'combine.' The arch-cell is, in fact, one of those 'external media,' without which we saw that no fusion or integration of a number of things can occur. The physical modifications of the arch-cell thus form a sequence of results, in the production whereof every other cell has a share, so that, as one might say, every other cell is represented therein. And, similarly, the conscious correlates to these physical modifications form a sequence of thoughts or feelings, each one of which is, as to its substantive being, an integral and uncompounded psychic thing, but each one of which may (in the exercise of the cognitive function) be *aware of things*—many and complicated—in proportion to the number of other cells that have helped to modify the central cell." *

We shall have occasion to discuss such theories from the point of view of localisation of mental function, and we shall see that we have no anatomical or physiological data for their support. We have not, as yet, been able to attach such anatomical or functional pre-eminence to any one cell or group of cells in the brain. We do not know the brain laws which determine an immediate correspondence between matter and mind; nor do we know the psychic laws which determine a correspondence between mind and matter: we can only seek to

* James, "Principles of Psychology," p. 179.

determine the laws which mutually or individually regulate the two totally different series of phenomena, and thus, by bringing them into apposition, endeavour to establish a psycho-physical law which shall embrace the requirements of both series of events. Many of the existing psycho-physical formulæ are the results of unsafe hypotheses within the domains of psychology and physiology respectively.

The student will find that the blind ends of physiology and psychology are covered respectively by unverifiable hypotheses, and that it is with the comparison of these blind ends that he has to do in estimating the *ultimate* nature and correlation of bodily and menta events.

Our ideas of the brain, and of its relation to the mind, are derived mainly from some showy results of modern science; but the modern scientist too often forgets that processes are no explanation of results. The theorists who evolve man from an ape see no likelihood that he will ever become an angel. Under the dogma of their one great law they settle the history of the past, and negative the possibilities of the future. Materialists say that the mind is derived from, or correlated to, atomic movement, and in order to prove a causal *nexus* they bring the analogy of the cosmical mechanism to bear upon the cerebral atoms. They seek to prove the existence of a mind correlated to the infinitesimally-minute counterpart of the cosmos; but there they end. They do not countenance any speculation as to the existence of a universal mind correlated to the infinite system from which they draw their analogy.

That our minds have a physical basis, without which their phenomena would not exist for us, is as true as the statement that life itself has a physical basis, without which it would not exist for us. Beyond this we cannot go, and the statement that mind depends upon the body in no way implies an explanation of the *causal* connection between the two states—*i.e.*, to state that one condition depends upon another is not to explain *how* it depends. The doctrines of *concomitance*, *parallelism*, and *simultaneity* furnish us with an *explicandum* and not an *explicatio*. Since an *explicatio* is impossible, we must devote ourselves with an equal amount of attention to the study of the heterogeneous states of mind and matter; and, in our endeavour to bring them into apposition, we must not venture upon any such *explicatio*.

Finally, it is happily obvious that our knowledge of the brain and its structures is gradually becoming more extensive. The anatomico-physiological school is striving to provide us with data, with the aid of which it is hoped we may be able to correlate mental facts. The explanation of the absolute reality of physical and psychical acts must remain outside physiological and psychological theories. The physiologist seeks to demonstrate the paths of conduction and dissemination of physical forces.* The psychologist seeks to demonstrate the method by which we think; whilst, lastly, the physiological psychologist seeks to establish some relationship between the two processes, without in any way attempting to throw light upon their ultimate nature or causal origin.

* See Batty Tuke, "On the Insanity of Over-exertion.'

CHAPTER I.

ANATOMY OF CORTEX.

Arrangement of Cortical Structures -- The Nerve-Cell — Processes of Nerve-Cells — Nerve-Fibres — The Relation between Cells—The Neuroglia, or Connective Tissue Basis Cell Elements—Caudate Fibre-Cells—Stellate Fibre-Cells—Protoplasmic Glia Cells.

PHYSIOLOGY OF NERVE-CELL.

Nutritive Function—Transmission of Nerve Impulses—Excitability and Conductivity—The Functions of Nerves—Negative Variation.

ANATOMY OF CORTEX.

BEFORE examining whether the areas of the cerebral cortex are allied with particular functions of the mind, it may be well for us to examine, somewhat carefully, the physical side, so that we may build our conceptions upon the basis of facts known to us. If we are to regard the mind as having its seat in the brain, we must study the material elements of which that seat is composed.

Starting with the assumption, justified by scientific observation, that the mind, as perceptive, has its seat within the nervous system, and that of this system the structural elements of the cerebral cortex have the greatest claims to being considered as immediately concerned with the occurrence of mental phenomena, it will be advisable to give some account of what is known as to the microscopic and chemical nature of these brain-elements. To enter into a description of the entire encephalon, with its membranes, vessels, tracts, and subordinate regions, would obviously be out of place here. Neither can we deal thoroughly with the anatomy of the convolutions, our knowledge of which has been so much advanced by the labours of Gratiolet, Ecker, Turner, Broca, Bevan Lewis, Ramón y Cajal, de Vaillet, de Mosso, Golgi, and others. *Comparative* investigations, in reference to the structural differences of the various regions of the cortex, have proved of great importance. The progression in complexity of structure, as we ascend the scale of animal organism, is significant, and the comparison of the structure and functions of the brain in different animals leads us to fairly definite conclusions concerning the human brain. We are almost compelled to believe that differentiation of cerebral function implies likewise a structural differentiation; but, as we shall see later, we do not yet understand the design of structural differentiation, as allied with psychical events. With the evolution of certain mental manifestations, we look for a corresponding advance in complexity of arrangement of the material elements. "Thus it is," says Bevan Lewis, "we expect the physiological areas ascertained by Ferrier to exist in the brain of the monkey and other animals to exhibit a structural differentiation characteristic of those parts, and hence helpful in the recognition of analogous regions in other orders. If it can be established that areas whose functional endowments are familiar to us present *uniformly specialised anatomical* features, we may reasonably conclude that other structurally differentiated areas, whose functions are unknown to us at present, nevertheless have each and all of them diverse endowments." In urging the importance of making ourselves acquainted with the intimate structure of the cortex, he pays this tribute to physiological experimentation that it alone can lead to conclusive results. "An attempt to delineate the homologous areas of the cortex in the different orders of mammalia by simple inspection would (on *à priori* grounds) only lead to failure; indeed, errors have already been frequently committed with respect thereto.

Arrangement of Cortical Structures.—To Ramón y Cajal, Retzius, Golgi, and Dejerine, we are indebted for the latest descriptions of the arrangement of cortical cells. Cajal describes four layers of cells in a typical Rolandic convolution—viz.: (1) A superficial zone, containing a few small fusiform cells, surrounded by numerous neuroglia nuclei; their long axis lies parallel to the plane of the surface, and they give off an apical and a basal process, which arises from the protoplasmic expansions, and not directly from the body of the cell. These processes never descend into the other layers, but run horizontally or slightly diagonally for a considerable distance, and in their course give off collateral branches, which form a rich terminal plexus. Collaterals are also sometimes given off by the axis-cylinder, which breaks up into two or three branches. Cajal also describes numerous polygonal, triangular, and unipolar cells belonging to this layer.

(2) The second zone contains a number of small pyramidal cells, with apical processes, which end in tufts in the superficial layer. Collaterals are given off from these apical processes, and also from the axis-cylinder process, just as in the superficial layer. The lateral expansions end without anastomosing with similar expansions of other cells. The "broad stripe" of Baillarger corresponds to this plexus.

(3) The third zone, or the zone of large pyramidal cells, resembles the second zone, except in the size of the pyramids, which are known as "*giant-cells*." These giant cells are found chiefly near the vertex, and the plexus formed by the collaterals of their axis-cylinder processes corresponds to the "thin stripe" of Baillarger.

(4) The fourth zone, or the zone of *polygonal* cells, contains cells which are egg-shaped, spindle-shaped, triangular, or polygonal. The apical processes of these cells do not reach the superficial zone, and the collaterals of the axis-cylinder process either end in terminal ramifications, or form a plexus round some of the nerve-fibres of the white medullary substance. In the last three zones, according to Golgi, there are also cells with a short axis-cylinder, and spindle-shaped cells, which send processes to the superficial (Marinotti) and second zone (Cajal).

Bevan Lewis has devoted much attention to the study of cortical lamination, and also to the local deviations in the general arrangements of cortical structures. He found that the distinctness of lamination not only varies with the local peculiarities of structure, but also with morbid states of the cortex, and with the full or empty state of its vessels. The

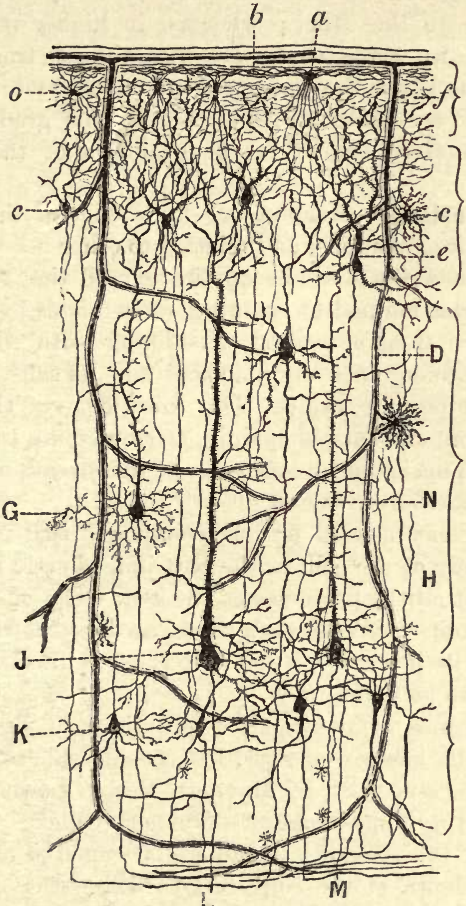

FIG. 1.

DIAGRAMMATIC VIEW OF CEREBRAL CORTEX.

a, caudate neuroglia fibre-cell; *b*, tangential fibre-system; *c*, protoplasmic glia cell; D, blood-vessel and perivascular space; *e*, cells of ambiguous layer; *f*, plexus of nerve-fibres and collaterals; G, terminal arborisation of dendron of pyramidal cell; H, long nerve-fibre ascending from white substance to branch and end freely in lacunar and molecular layers; J, pyramidal cell with neuron and dendrons; K, fusiform nerve-cell of polymorphic layer, with ascending axis-cylinder; L, neuron from pyramidal cell giving off collaterals; M, neuron from cell of ambiguous layer; *o*, transitional form between caudate and stellate fibre-cell.

eight laminar types of cortex, described by Bevan Lewis as occurring in mammals, are characterised by abrupt transitions from one type to the other; whereas, in higher mammals, and especially in man, there are no abrupt transitional regions. In the latter, the passage from one form to another is gradual, and, according to Bevan Lewis, this gradual passage is a distinctive element in the evolution of the higher brains.

The Nerve-Cell.—Much of our knowledge of the nerve-cell—its structure, functions, and relation to other nerve-cells—has been obtained by Marchi's application of the Wallerian methods, and the method of staining *intra vitam* by methyl blue (Ehrlich). Golgi's method of staining with nitrate of silver, after treatment with chromic acid and its salts, has also yielded most important results. Our knowledge of the paths taken by action currents is mainly attributed to the Gotch and Horsley's physiological methods of investigation by the galvanometer and electrometer.

The term "nerve-cell" is now commonly used to denote not only the body of the cell, or the part immediately inclosing the nucleus, but all the processes of the cell. The adoption of the term "neuron," in Waldeyer's sense, as denoting the whole nerve-cell and its processes, is liable to cause confusion, and is acknowledged to be undesirable.

The significance of the relative variations in size of different nerve-cells has given rise to a considerable amount of discussion, more especially by Meynert, Bevan Lewis, Ramón y Cajal, and Hughlings-Jackson. Meynert believes that the relative size of the so-called "giant-cells" may be attributed to the greater depth of the convolutions where they are to be found; "the apex processes of these cells, therefore, having to traverse a greater distance in their low-lying groups ere they reach the outer layer of the cortex." To this assertion, and to the explanation that the grouping of these cells is due to their being pressed together by the bundles of nerve-fibres passing upwards from the medulla of the gyrus, Bevan Lewis takes exception, and finds a more probable explanation in the age and multiplicity of the surrounding connections of the nerve-cell.

"If we carefully note a section of fresh brain, we find that although the majority of the pyramidal cells steadily enlarge at greater depths, the ganglionic cell clusters, but a very short remove from the largest pyramidal cells, represent an enormous leap in dimensions." . . . "This we believe to be the case; we find as a constant accompaniment of increasing bulk, much complex relationships with surrounding cell-districts —in other words, *the larger the cell* the *greater the number of its branches.* But the older the nerve-cell, the longer time has it had for the establishment of organised relationships around; and hence it follows that the *older cell* is also the *larger element.*"*

To another factor—namely the *medullated fibre* (axis-cylinder process)—considerable importance is also attached:—

"The medullated fibre, which arises from the basal extremity of the great motor cells, traverses uninterruptedly an enormous distance to reach the respective cell groups, which represent in the spinal cord the musculature of the limbs. The distance traversed is very unequal between the lumbar and cervical groups: the cortical centres representing the lower extremities having not only a greater distance through which to discharge their energy, but a far more massive musculature to call into activity, than is the case with the arm centres of the cortex. Again, the cortical centres for the upper extremities not only act through a greater range, but they innervate larger groups of muscles than do the centres for the head and neck—the muscles of articulation, deglutition, etc. It would, therefore, be natural to presume that the cortical cell groups representing these respective regions would differ considerably in the size of their individual elements. The histology of the motor area fully warrants us in stating this to be the case; the smallest cells being found at the lower end of the central gyri, and Broca's convolution, and thence increasing rapidly in size upwards towards the centres for the musculature of the limbs." *

The study of the comparative size of the nerve-cells would, therefore, seem to yield the law that "*the greater musculature is presided over by the groups of largest cells,*" and this conclusion is in accordance with the suggestions of Hughlings-Jackson and others. Bevan Lewis believes that the relative dimensions of the cells are dependent on (1) range of discharging distance; (2) size of musculature innervated; (3) age of nerve-cell; (4) resulting multiplicity of cell connections.

Undoubtedly the size of the nerve-cell often bears a distinct relation to the length of the processes which leave it, and an examination of the bulbar-spinal cells groups, and the larger

* Bevan Lewis, "Mental Diseases," p. 107.

projection-cells associated with the part of the cerebral cortex, from which the fibres of the pyramidal tract originate, leads to the same conclusion. The same law also holds good for the ganglion-cells of the retina. Professor Schäfer, however, believes that this is not an invariable rule, and he doubts whether it will apply to the visceral and vascular nerves. If we look at the dorso-mesial group of cells (Clarke's column) in the spinal cord and compare the individual cells with those of the anterior horn, we see that there is a great resemblance in form but not in size: the diameters of the former varying from 40 to 90 μ, whilst in the latter the motor cells measure from 67 to 135 μ. In the lower part of the dorsal region, Clarke's column is best developed, and the cells have a relatively larger size than elsewhere. This region is also characterised by a comparatively smaller development of the cells of the anterior cornu. If we accept Gaskell's view, that the number and size of cells in Clarke's column in any particular region appear to vary as the number of leucenteric fibres derived from that region, and if, as the result of Gaskell's researches, we believe that this column is connected with the visceral nerves, are we not also free to assume that the relative size of the cells falls under the general law? In a similar way, in the medulla oblongata the cells of Clarke's column, which retain the same characters as in the cord, swell out into the nucleus of the vagus, the great leucenteric nerve of the thoracic viscera.

The relative size of the nucleus of the nerve-cell is regarded as being of peculiar significance, and here, again, we cannot do better than quote from Bevan Lewis, who says:—

"When, however, we consider the *assumed* sensory element of the cortex—the minute angular and granule cells—we must not lose sight of a remarkable distinction between them and the assumed motor unit, and that is, the great proportionate preponderance of the nucleus to the cell in the former. That the nucleus does exert some mysterious influence over the nutritive and functional activity of the cell has been long surmised; and the results of our histological inquiry indicate that nuclear degeneration within the nerve-cell is peculiarly associated with certain states of mental and motorial instability. We have long been accustomed to regard it as related more definitely to the functional activity of the cell, and less directly related to the nutritive activity of the cell. In other words, the cell is subject to a constant supply of nutritive plasma, it gradually assumes a state of nutritive instability, and will necessarily discharge its accumulated energy in accordance with the simple law of nutritive rhythm, the resulting stable equilibrium is succeeded by a measurable period ere the potential energising of the cell has once more brought it up to its former state of instability. Were this all that occurs, the process of storage and liberation of energy would be a simpler rhythmic process than the more compounded rhythm which actually pertains to mental operations.

If, however, we regard the nucleus as affecting the functional activity of the cell, as, in fact, restraining or inhibiting its discharge, as a kind of *imperium in imperio* exercising a controlling influence upon the perturbations which reach the cell from sensory surfaces; then the presence of a healthy nucleus would become an all-important feature in the cell life—a feature of the utmost significance to us in our pathological inquiries. The view we have here taken of the significance of the nucleus would lead to the conclusion that when, from its degeneration or morbid state, it fails to inhibit the cell, these nerve-elements would be subject to a rapid running down on trivial excitation, and in servile obedience to the law of nutritional rhythm; in fact, we should here find an explanation of morbid instability, such as, *e.g.*, in motor realms results in convulsive states, and in the substrata of mental operations in varied psychical states and reductions of consciousness.

It is these considerations which induce us to regard the disproportionately larger nucleus of these smaller angular elements of the second layer of the cortex as being of some significance. Subject, as such minute cells are, to a rapid accumulation of energy, we might presume that some restraint might be established to prevent their reckless liberation of energy, and hence we believe such restraining capacity to be afforded by the very large nucleus. In the next place, we have every reason for believing that this superficial belt of angular cells is in direct organic connection with the subjacent cells of large size, and that their morbid instability would, therefore, affect these larger units, which, from the small size of their nucleus, would be more subject to the law of nutritional rhythm in their discharge of energy. As indicated by Dr. Ross, and also in the preceding note by Dr. Hughlings-Jackson, the large cell would present a far smaller area in contact with the nutrient material than the same amount of protoplasm broken up into numerous minute elements; and hence, such large cells would labour under nutritive disadvantages, would be reservoirs for the slow accumulation and storage of energy, which, when liberated, would again result in a tardy reinstatement of nutritive instability."

Processes of Nerve-Cells.—Every nerve-cell has one or more processes. These processes are of two kinds, termed "*neurons*" and "*dendrons*."* "Neuron" is used to signify those processes which first show themselves in the course of

* Schäfer, "Brain," 1893, p. 136.

development of the nerve-cell, and which hitherto have usually been styled as the axis-cylinder or nerve-fibre processes. The term "dendron" is applied to the protoplasmic processes of Deiters, which are regarded as not being so essential, since many cells are entirely destitute of them. The term "neuro-dendron" is used for combined processes, such as occur in the motor nerve-cells of arthropods. The classification of nerve-cells, according to the number of their processes, is regarded as unsatisfactory; the terms uni-polar, bi-polar, and multi-polar not distinguishing between the kinds of processes. All processes of nerve-cells are ultimately dendritic, and, almost without exception, the neuron, or nerve-fibre process, although it may have a course of several feet without giving off a branch, finally ends in a terminal arborisation. Schäfer gives examples of this fact in the arborisation of the nerve ending in muscles, and in the arborisation of nerve-fibrils in sensory structures, such as the cornea of the eye, and the epidermis of the skin. He also adds that even where a nerve-fibre apparently ends in a simple extremity it can generally be noticed, as in the corpuscles of Pacini, and in the tactile corpuscles of Meissner, that the actual ending of the essential part of the nerve-fibre is really arborescent. There are some nerve-cells which have no dendrons, and others which have many dendrons; all, however, possess at least one neuron. A primary distinction is therefore made between *dendric* and *adendric* cells; and, according to the number of neurons, the cells are classified into those which are *mononeuric* and those which are *polyneuric* (dineuric, trineuric, etc.), according as we find one, two, or more neurons or axis-cylinder processes emanating from the cell-body or from any of the dendrons. As examples of the mononeuric class, Schäfer takes the cells of the anterior horn of the spinal cord, many of the cells of the cerebral cortex, and the large cells of Purkinje of the cerebellum; whilst, as instances of the polyneuric class, he quotes, on the authority of Ramón y Cajal, the superficial cells of the cerebral cortex, and he also refers to his own observations on the nerve-cells of the neuro-muscular sheet of the Aurelia. This classification of nerve-cells, therefore, is based upon the kinds of processes which they possess, and, according to the number of neurons, the number of dendrons being considered as of minor importance. For the cell with a long axis-cylinder process the term *projection-cell* (Fig. 2) is used, to distinguish it from the *intermediary cell* with its relatively short axis-cylinder process.

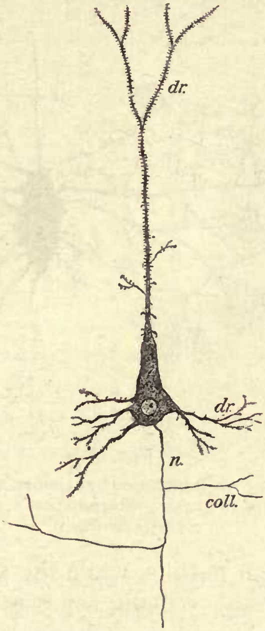

FIG. 2.

PROJECTION-CELL OF CEREBRAL CORTEX (DIAGRAMMATIC).
dr, dendrons; *n*, neuron; *coll.*, collaterals.
(*Slightly modified from Schäfer.*)

Golgi, who was the first to describe the relative size of the neurons, regarded those cells with comparatively long neurons as being concerned with the giving out of efferent impressions; those with relatively short and soon-branching processes as being sensory or receptive in function. Schäfer employs the term "intermediary cell" to imply that, the cell in question offers an intermediary link between centripetal impressions, which may be brought to a nerve-centre by the neuron of a sensory projection-cell, and centrifugal impressions which pass away from the nerve-centre by the neurons of motor projection-cells.

Ramón y Cajal has given the term "*collaterals*" to the fine branches which are now demonstrated as coming from the neuron. The difference in appearance between the two kinds of processes, when prepared by the Golgi method of staining, is readily detected by an experienced observer. The dendrons

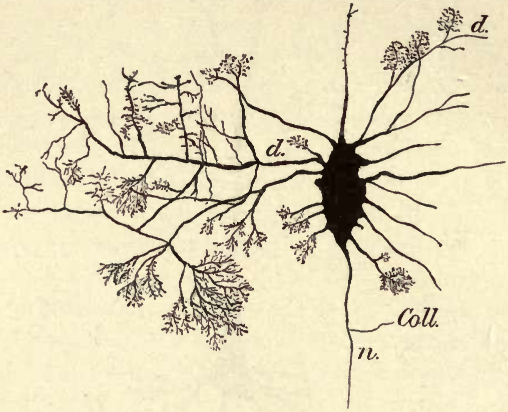

FIG. 3.

CELL OF IRREGULAR PYRAMIDAL TYPE.
d, dendrons terminating in feathery arborisations; *n*, neuron; *coll.*, collateral.
(*After Berkley.*)

usually have a rough outline, while the neurons are generally smooth. The neurons remain comparatively unchanged in diameter along their course, whereas the dendrons branch repeatedly, and hence gradually diminish in size (Fig. 3).

Nerve-Fibres.—Nerve-fibres represent to us a conducting apparatus, and they form a means of connection between the central nervous organs and the peripheral end organs. Of nerve-fibres we have two kinds: (1) *non-medullated* nerve-fibres, and (2) *medullated*. Of the non-medullated form, the simplest is that of the *primitive* nerve-fibril, which is very delicate, and is often found exhibiting small varicose swellings in its course. These fibrils form by the splitting up of the axis-cylinder of the nerve-fibre near its termination, as seen in the terminations of the olfactory fibres, in the optic nerve-layer in the retina, in the corneal nerves, and in the terminations in non-striped muscle. Similar fibres are also to be found in the finely divided processes of nerve-cells in the grey matter of the brain and spinal cord. A second variety is to be seen in the axial-cylinder process of nerve-cells, in which primitive fibrils are held together in bundles by a slightly granular cement, which gives them a very delicate longitudinal striation and finely granular appearance. These are termed *naked*, or *simple axial cylinders*. Remak has described a third variety in the pale non-medullated fibres which are found in abundance in the sympathetic nervous system. They consist of an axial cylinder which is inclosed by a delicate, structureless, and elastic sheath, corresponding to the sheath of Schwann. Ranvier, however, denies the presence of this sheath, and believes that the nuclei are merely applied to the surface, or slightly embedded in the superficial parts of the fibre, and that they belong in reality to the fibre itself. These differ from medullated fibres, inasmuch as they branch and form an anastomosing network. When acted upon by silver nitrate they never show any crosses.

Medullated fibres occur, also, in several forms. In the white and the grey matter of the brain and spinal cord we meet with axis-cylinders, or nerve-fibrils, covered only by a medullary sheath or white substance of Schwann. These are also called *varicose* fibres, from the fact that after death they often present varicose swellings due to the accumulation of fluid between the medulla of myelin and the axis-cylinder. They are medullated nerve-fibres without any neurilemma, and they have nodes of Ranvier. The great mass of the cerebro-spinal nerves, however, is largely constituted of medullated fibres having the sheath of Schwann. These fibres are highly refractive, homogeneous, and exhibit a double contour, their margins being dark and well defined if acted upon by reagents. Each fibre consists of (1) Schwann's sheath (neurilemma or primitive sheath), which is thin, clear, and has nuclei in it; (2) medullary sheath, or white substance of Schwann, which surrounds the axis-cylinder and has been compared to an insulating medium round an electric wire. This substance is quite homogeneous, glistening, and refractive. It is of fluid consistence, and this fluid can be squeezed out of the cut ends of the fibres in spherical drops. After death this substance shrinks slightly from the sheath and breaks up into droplets, not due to coagulation, but, according to Toldt, to a process like emulsification, the drops pressing against each other. It contains a large amount of lecithin and cerebrin, which swell up to form myelin-like forms in warm water.* It also contains fatty matter, is blackened by osmic acid, and rendered transparent by chloroform, ether, and benzine.

The *axis-cylinder*, which lies in the centre of the nerve and is essential to it, is usually cylindrical and composed of fibrils united by a cement of semi-fluid consistence. Kupffer describes a fluid—"neuro-plasma"—which lies between the fibres. According to other observers, however, the whole cylinder is inclosed in an elastic sheath, peculiar to itself and composed of neuro-keratin.† To this sheath Kühne has given the term *axi-lemma*. There are, in addition, certain structural modifications which require notice. The *nodes* or *constrictions of Ranvier* occur at regular intervals along a nerve-fibre. At these points of constriction the white substance of Schwann is interrupted, so that the sheath lies upon the axis-cylinder. The presence of one or more nuclei in each *inter-annular* or *inter-nodal* segment has led to the belief that the whole segment is equivalent to one cell. These nodes are regarded as being concerned with the diffusion of plasma through the outer sheath into the axis-cylinder, and the giving off of the decomposition products. Each segment is looked upon as being built up of a series of conical sections, each of which is bevelled at its ends. These bevels are arranged one over the other in an imbricate manner, showing slight intervals between. The oblique lines running across the white substance are termed the *incisures* of Schmidt or Lantermann. In addition to the nucleated nerve-corpuscles, which are found at intervals under the neurilemma, other nerve-corpuscles or "*demilunes*" have been described as quite distinct. These latter are stained yellow by safronin, while the ordinary nerve-corpuscles are stained by methylanilin.‡ Ewald and Kühne state that the axis-cylinder, as well as the white substance of Schwann, are covered with an excessively delicate sheath of *neuro-keratin*, and the two sheaths are connected by numerous transverse and oblique fibrils which permeate the white substance.

The nature of the fibrillated appearance of the axis-cylinder,

* Landois and Stirling, 3rd edit., p. 528.
† Ibid., p. 527. ‡ Ibid., p. 518.

as seen both in neurons and dendrons, is still a matter of conjecture. Max Schultze regards the axis-cylinder as consisting of two substances—viz., a bundle of fine fibrils (ultimate fibrillæ) which serve as conductors, embedded in a clear substance like protoplasm; and his observations upon the structure of the non-medullated fibres of the olfactory nerve, and of the axis-cylinder of the ordinary medullated fibres, go to prove an anatomical discontinuity of the fibrils. Schäfer argues that this is further borne out when we trace the ramification of the nerve-fibre at its peripheral extremity; as, for example, in the cornea, and even in the nerve-endings of the motor nerves upon the so-called end plates, where there is to be seen a complete separation of the fibrils which have composed the axis-cylinder, and which end here in the ultimate branchings of the axis-cylinder.

The occurrence of varicosities upon the nerve-fibrils is regarded as an additional proof that they are excessively fine-walled tubules filled with fluid. The opposing views of Heitzmann, Leydig, Fromann, and Nansen, are, that the nerve-fibrillæ of the axis-cylinder are nothing but a repetition of the reticulum of fibrils, as seen in the protoplasm of all nerve-cells; the reticulum having, in this case, been drawn out to such an extent that its meshes have become extremely elongated, and its fibrils, to all appearance, parallel and distinct.* Nansen believes that the apparent fibrils are really the optical longitudinal sections of sheaths or septa of spongioplasm, which subdivide the fibre into tubes filled with hyaloplasm, which forms the true conducting material of the nerve-fibre. Engelmann † agrees that the fibrils appear to be distinct, and are never seen to anastomose or form a plexus of fibrils. He does not see, however, how these subdivisions of the axis-cylinder can fulfil any separate function as the conductors of nervous impulses, on account of the closeness of their contact, and the smallness of their number, as compared with that of the fibrils into which the fibre breaks up at its peripheral termination. ‡ From the experiments of Engelmann, by treating the axis-cylinders with nitrate of silver, the question as to

* Schäfer, op. cit., p. 144.

† "Pflüger's Archiv.," xxii. p. 26.

‡ Ladd, "Physiolog. Psych.," p. 40.

the continuity of the axis-cylinder through the annular constrictions is by no means settled. The fact that the axis-cylinders, as a rule, when treated in this way, were broken off at the annular constrictions does not disprove their discontinuity, and possibly there may be exceedingly minute hour-glass constrictions at these nodes. These fibres are regarded as composed of a number of annular segments cemented together—each separate fibril placed exactly end to end with its fellow in the adjoining segments—and possibly such an arrangement would accord with the theory which regards the segments as elongated and developed nerve-cells. Bevan Lewis regards the question of the homogeneity or, so to speak, of the fibrillated constitution of the axis-cylinder as of fundamental importance, and if we are to look upon such fibrils as isolated tracts of conduction throughout their length, the nerve-fibre and the cell itself have a far different significance.* He points out that *visible* continuity of the fibrillæ is not essential. More or less fusion may occur throughout the length of the fibre; and the splitting up into fibrillæ may only be observed at the centric and peripheric terminations as an indication of the fibrillar constitution of the axis-cylinder and its lines of molecular disturbances. The significance of *Fromann's lines* is unknown. These lines are to be seen as transverse markings when the axis-cylinder is treated with nitrate of silver. The silver solution seems to penetrate at the nodes, where it stains the cement substance and also part of the axis-cylinder, giving the characteristic striation.

The Relation between Cells.—The relation which nerve-cells bear to one another is important though still somewhat doubtful. Of late, however, much valuable work has been done in this direction, and much evidence has been accumulated to show that—(1) there never is direct union of nerve-cells by distinct and comparatively coarse fibres; (2) there is no union of nerve-cells by means of the ramifications of the fine dendrons, which formerly were supposed to pervade the whole grey matter of the nervous system as a fine fibrillar net-work; (3) every nerve-cell, with all its processes, is a distinct and isolated anatomical unit.† Schäfer believes that, with great

* Op. cit., p. 92. † Schäfer, op. cit., p. 147.

probability, the only connection of one nerve-cell with another is a physiological one, and that it takes place by the adjunction of the arborised process or processes of one nerve-cell, either with the cell-body of another cell, as in the cerebellar cortex, or by the adjunction and interlacement of the arborised processes of one nerve-cell with similar arborised processes of other cells, as in the olfactory glomeruli. In fact, we may regard the basis of the grey matter of the nervous system—the granular-looking substance in which the nerve-cells are embedded—as an extremely fine interlacement of ramified processes, not only of the nerve-cells which actually lie in that particular grey matter, but also of nerve-cells which lie in other parts of the nerve-centres, or even in the peripheral parts of the nervous system, and which, on arriving at the grey matter, break up into a fine arborescence of nerve-fibrils.* The *neuroglia or connective basis* is, according to Bevan Lewis, composed of a structureless or *finely molecular basis-substance*, and *connective cell and fibre networks*, which act as a supporting and protective material, and differ in special qualities in different regions. In the spinal cord the binding material is in the form of large-sized nucleated cells, with numerous lengthened ramifying processes, together with a plexus of fine fibrils; whilst a structureless or very finely granular material is found here but sparingly. Nearer the periphery of the cord this connective sheath becomes more fibrillar. In the grey matter of the cord, and in the grey matter of the cortex, the molecular basis preponderates over the fibrillar elements of the neuroglia; whilst in the medulla of the brain the amount of connective-fibre element exceeds that of the molecular element. In affirming that this basis-substance (*Punktsubstanz*, of Leydig), is finely molecular and structureless, Bevan Lewis hardly, perhaps, pays sufficient tribute to the numerous observations which have accumulated since the employment of the methods of Ehrlich and Golgi. By these methods the so-called *Punktsubstanz* is shown to be made up of the ramifications of fibres derived from the neurodendrons of the large motor nerve-cells. The *Punktsubstanz* is now generally regarded as being made up of the ramified processes and their somewhat varicose ends. These processes

* Op. cit., p. 148

are part of the nerve-cells of the central ganglia, and also of the nerve-cells at the periphery. The observations of Retzius, Rohde,* and Biedermann† also support this view.

The cell-elements of the neuroglia are of two kinds, and these differ from one another in regard to size and connections. The smaller of the two kinds of cell vary from 6μ to 9μ in diameter. Their nucleus is spheroidal and relatively large, and it is surrounded by an extremely delicate protoplasmic investment. According to Bevan Lewis, these cells are to be found in three situations: (1) irregularly in the neuroglia framework; (2) in regular series round the nerve-cells; and (3) in more or less regular succession along the course of the blood-vessels (capillary and arteriole). The larger cells are usually 13μ in diameter, and have a relatively larger amount of protoplasm as compared with the size of the nucleus. These cells are also frequently flask-like in appearance, and may contain several nuclei. Their processes are numerous, extremely fine and radiating. The want of affinity of these elements for the staining agent (anilin) has led to the conclusion that they are non-nervous in character.

By the employment of a modification of Golgi's method of staining, Andriezen has demonstrated two great morphological groups of neuroglia elements, which he has termed (*a*) neuroglia fibre-cells, and (*b*) protoplasmic neuroglia-cells. Of the neuroglia fibre-cell he describes two species. One species is situated in the first layer of the cortex, and sends its streaming fibres down into the third layer: these are the caudate fibre-cells (Fig. 4). The other species is situated in the medullary substance or white matter, and has radiating fibres passing in all directions: these are the stellate fibre-cells.

The *caudate fibre-cells* form a distinct feature in the first layer of the grey matter. The bodies of the cells are embedded in the grey substance, and their apices are rounded and pointing downwards, thus giving rise to "tail-like tufts" of smooth fibres, which pass into the deeper layers of the cortex. From the wider ends of the bodies there arises a system of radiating tangential fibres. Andriezen describes the individual fibres

* "Histologische Untersuchungen über das Nervensystem der Polychäten," Breslau, 1887.

† "Jenaische Zeitschr. f. Naturwissensch.," 1891.

as extremely long, smooth contoured, and of uniform calibre throughout; as being of remarkably uniform thickness one with another, unbranched, slightly wavy in their course (which is, on the whole, almost rectilinear), and as exhibiting here and there small sharp curves and small angular bends, while sharp transverse fractures are not infrequent. These fibres formed a fine cortical fretwork, and none of them could be demonstrated as forming an anastomosis, nor did they appear to have any special vascular connections.

The *stellate fibre-cells* have small and indistinct bodies, mainly constituted by the enormous number of fibres which

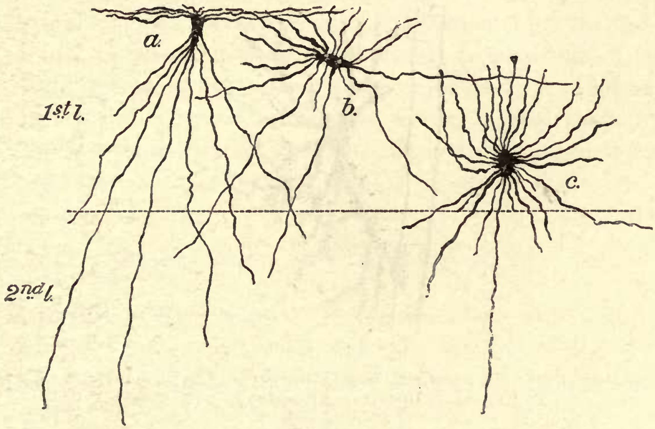

FIG. 4.

THREE NEUROGLIA FIBRE-CELLS.

a, caudate cell; *b* and *c*, transitional forms between caudate and stellate fibre-cells; 1st *l.*, first layer; 2*nd l.*, second layer of cortex.

(*After Andriezen.*)

meet and intercross them. Many of the neuroglia fibres pass through the cell-body. According to Andriezen these are remarkably like the fibres of the caudate fibre-cells in calibre and contour, and exhibit the same peculiar sharp curves and angular bends in a course otherwise straight, and also the same transverse fractures. They stain of the same colour, never branch or anastomose, are of considerable length, and do not exhibit the special vascular attachments which the protoplasmic glia-cell exhibits.

The *protoplasmic cell* (Fig. 5) is said by Andriezen to occur abundantly throughout the grey matter of the cortex, and but rarely in the medullary substance. It is of mesoblastic origin, and exercises a lymphatic function. Its processes are stellate or dendritic in arrangement, and the lymph-spaces which surround its coarse, shaggy processes, are in direct communication with the perivascular lymphatics. Bevan Lewis regards these large protoplasmic cells as forming the actual extremities of the lymphatic system, and he maintains that their thick processes end in the perivascular or hyaline sheath, whilst the finer reticulated processes extend through the neuroglia network.

FIG. 5.

PROTOPLASMIC GLIA-CELL FROM THE HUMAN BRAIN (1ST LAYER OF CORTEX), SHOWING ONE EXPANDED DISC-LIKE ATTACHMENT TO A VESSEL.
(*After Andriezen.*)

These protoplasmic glia-elements are regarded by Andriezen as being the elements which exhibit a morbid hypertrophy in pathological conditions (alcoholism, general paralysis). They also show further morbid activities, in the last stage of which their protoplasm deposits numerous organised fibrillæ, in the act of doing which the protoplasm proper is used up. A scanty remnant may persist, ghost-like, to mark the position of what was once a protoplasmic cell-body.* These protoplasmic cells are now regarded as lymph-secreting cells. Andriezen believes that the cell absorbs or takes up lymph from the brain-tissue which it permeates, and that it discharges it, through its peri-dendritic canaliculi, into the perivascular lymph spaces.

* Andriezen, "British Medical Journal," July, 1893.

Other small glia-cells, sometimes mistaken for leucocytes, with sharply-defined nuclei and a small quantity of protoplasm, have been described as surrounding the larger nerve-cells as they lie in their pericellular sacs. Their function, however, is unknown.*

Bevan Lewis regards the protoplasmic cells as comprising the distal extension of a lymphatic system, and he has clearly pointed out that arrest to the escape of perivascular lymph from the cortex is immediately followed by a morbid development and by a hypertrophic condition of these "spider cells." The question of the significance and nature of these cells in morbid conditions has been freely discussed of late. Bevan Lewis attributes to them an active and aggressive part in the production of disease, and thereby somewhat enlarges the notion of their function as "scavengers" to remove waste products. The more generally accepted opinion, however, is that their rôle is probably a secondary one, and that they remove rubbish instead of producing it.†

PHYSIOLOGY OF THE NERVE-CELL.

Nutritive Function.—The nerve-cell's most important function is that of nutrition, and the presence of a nucleus seems to be essential to this. When a nerve-fibre—*i.e.*, a process of a nerve-cell—is cut—no matter whether, in its normal state, it conducts impulses to or from the cell—the part which is cut off from the parent cell must die. This nutritive function of the nerve-cell has been insisted upon by Nansen,‡ who believes that the cell-body has no other function than that of effecting the nutrition of the whole cell, and more particularly that of the axis-cylinder process.

Schäfer points out that although the nutritive function may be the one essential function of the nucleated body of the nerve-cell, there are many cases in which the body of the cell also serves for the *transmission of nerve-impulses.* As examples, he gives the bi-polar cells, through which impulses must of neces-

* Andriezen, "Brain," 1894, p. 664.
† Carter, "Brain," 1893, p. 399.
‡ "Histological Elements of the Central Nervous System," Bergen, 1887.

sity pass; and the motor projection-cells of the spinal cord and bulb, in which instances nerve-impulses are probably communicated to the body of the cell from the interlacement of nerve-fibres derived from other cells, which enfold the body of the motor cell.

Whether nerve-impulses really traverse the cell body is still open to discussion. Schäfer believes that in some instances nerve-impulses can be transmitted along nerve-fibres without traversing a nerve-cell at all, and he even goes a step further, with the conception that sensory-impulses may become converted into motor-impulses within the *Punktsubstanz* without necessarily traversing the motor nerve-cells at all; the latter being only connected with the Punktsubstanz by dendritic collaterals, which pass off from their large neuro-dendritic processes. Our knowledge of the modes of neural motion—*i.e.*, the methods of propagation of nerve-impulses—is absolutely untrustworthy, and we have yet to solve this problem. Hence we readily see that before an attempt is made to find the solution of psychical phenomena in terms of neural molecular motion, we must arrive at some more definite conclusions as to the nature and workings of the material structure.

Excitability and Conductivity.—The two forms of molecular motion which characterise both nerve-fibres and nerve-cells may be called excitability and conductivity. The former is looked upon as the motion originally set up in the nervous elements, and corresponds to the excitation of a stimulus; the latter represents the propagation or conduction of this initial excitation along tracts to other regions.

The *external* and *internal stimuli*, and their relation to excitation, will be dealt with later. Here, however, we must ask the question, Do nerve-cells act as generators of nerve-impulses? It is almost universally held that they do, in which case such commotions are regarded as being essentially *automatic*. Let us take, as an example of automatic action, the action of the respiratory centre, and let us endeavour to eliminate from it all sources of stimulation from without. In order to do this we must exclude the chemical stimulation which results from varying conditions of the blood: we must also cut off the possibility of stimuli reaching the centre from the periphery, or from any other regions whatever. When we have direct proof that nerve-impulses are generated in the nerve-cell under such circumstances, then only shall we be able to say that such impulses arise automatically. The end organs of sense are excited specifically by their appropriate stimuli; the afferent nerves have their specific function of conduction from these end organs of sense; the efferent nerves have their specific function of conduction from the central organs, and we are not in a position to say that nerve-cells ever do give rise, without some mode of stimulation, to automatic action. We have already seen that nerve-impulses may be transmitted without passing through the nerve-cell at all; and, further, the power possessed by the body of the cell of transmitting impulses, when stimulated, is not unique in it, but is equally shared by its processes under precisely the same conditions. "It is," says Schäfer, "a function which is not special either to the cell body, or to the processes, but is common to both."*

When a stimulus is transmitted by a ganglion-cell, so as to impart motion, such action is termed reflex, and the ganglion-cell is said to possess *reflex function.* This form of action is the simplest nervous process with which we shall have to deal. Stimulation and reaction are the main conditions of nerve life, and they are essentials of nervous function. Throughout the whole of animal life we see this function exhibited in its innumerable modes and degrees. The mere recognition, however, of this fundamental property, as pertaining to all life, does not imply any explanation of the phenomena in terms either physical or psychical. The phenomenon is essentially the same in its rudimentary form in the amœbæ as in its more complex developments through the paths of conduction in man; and we must never lose sight of this fact, that no matter how clear our knowledge may become of the excitations of stimuli, of the methods and directions of their conduction, and of their numerous expressions as forms of motion, we are in reality no nearer the solution of the all-important problem—the ultimate

* Eckhard made a distinction between the *automatic-tonic* and *automatic-rhythmic* functions of the ganglion-cells, according as the movements over which the cells exercised control occurred at irregular or regular intervals.

conditions of vital reaction. On the physical side we imagine that within the nerve-cell afferent impulses become modified as to number and character by profound molecular changes, so that they become transformed into efferent impulses of another kind. In reality, however, we do not know how the effects of stimuli are conveyed to the ganglion-cell; we do not know what becomes of the excitations within the ganglion-cell; nor do we know how the modified afferent impulses are propagated to their destinations. When we come to consider the phenomena of mind, and discuss the various physiological theories which have been advanced to explain those phenomena, we shall see that the endeavour to find a complete expression for all mental acts in physical terms is, to say the least, premature, and scarcely warrantable in our present state of knowledge.

This leads us to the question, Has the nervous process of a simple reflex action a concomitant psychical process which corresponds to it? When we consider the plantar reflex, which is manifested even though psychical life is supposed to be non-existent, we are able to answer in the negative. The essential anatomical elements involved by the processes of reflex action are known to us, but the nature of the psychical process, or the extent of its concomitance with the physical process, is unknown. Ziehen says our consciousness, which is alone able to decide the question, negatives the idea of such a correspondence. If our foot is but pricked unawares, it is only after the movement has been executed that we become aware of what has taken place by a resultant sensation—the sensation of motion.

The fitness of reflex action has been given as an argument to support the theory that there is a psychical concomitance with the physical process. In every reflex act we are forced to believe that the physical process is not confined to a single afferent or efferent nerve or ganglion-cell. On the contrary, many are affected; and if we are to explain the correspondence of a psychical event, we must establish a correspondence not of one psychical event with one physical process, but with many physical processes. These physical processes may lead to one result—namely, the motor effect—and in the lower forms of reflex action the result tends to remain the same, no matter how the sensible stimulus may change; but the *con-*

sciousness of the excitation, or of its resulting effect (motion), must of necessity be, not the correspondence with one physical process, but with many. The lower forms of motor reaction do not seem to depend entirely upon the character of the stimuli. There is, however, a general fitness in their reaction, and it is upon this fitness or unfitness of our reflex mechanism that our survival, as physical organisms, in great part, depends. The argument that this fitness implies a psychical correlate—*i.e.*, that lower reflex acts which are fitting demonstrate their psychical nature—is of great importance as bearing upon the evolution of the mind in animals and man. Nerve-cells are believed to have the power of diminishing or intensifying the nerve-energy entering them. Thus the sensory stimulus may become more complicated in its course of transmission. In the higher form of reflex action—in which co-ordination is evidenced—the concomitance of a psychical process has been assumed. The nature of this complicated motor reaction has given rise to much discussion and difference of opinion. Ziehen believes we have no ground whatever for assuming that these higher or more complicated reflex acts are accompanied by psychical processes. Those motor reactions, however, which are not the invariable result of a definite stimulus, but are the modified result of new intercurrent stimuli, may be called *automatic acts* or *reactions*, using the term automatic in its more restricted sense, and not including the so-called automatic rhythmical movements which are the result of internal stimuli. The instance given us of the pianist who executes an often-practised piece of music while his thoughts are wandering elsewhere, is of great significance, and the explanation is, that the visual image of the notes and the sensations of touch, imparted by contact with the keys, act without interruption upon the execution of the movements of the fingers. In an example of this kind the transmissions of the excitations may be explained as occurring along the lines of least resistance—along fixed paths, or so-called paths of conduction.

Further, we may conceive the occurrence of structural modifications in these paths of conduction with the constant execution of definite functions; but how are we to explain a still higher form of reaction, in which an individual is able to extemporise and construct new combinations whilst his mind is engaged elsewhere, or, at the most, is only dimly conscious of the working of his reflex mechanism? Such instances are not uncommon, and the musician may possess a reflex mechanism of such exquisite sensibility that its constructive effects may be wrought without any obvious psychical correlate. An analysis of this phenomenon, however, is permissible, and we shall see that, in reality, this constructive power is an advanced development of the general fitness of reflex action *plus* intercurrent stimuli. As in the former instance, the pianist's fingers, in spite of his absence of mind, glide over the notes in proper succession, and his movements tend to act in lines of least resistance. No effort of memory is involved in a psychical sense. Co-ordinative actions, which have been acquired formerly, now succeed each other in a relatively new order or sequence. Experience has taught the fingers how to avoid consecutive fifths and octaves. Relative progressions and intervals are treated with an equal amount of accuracy. The hands approximate to, and diverge from, each other, and so accurate is their judgment of distance, that, taking their clue from one another, the fingers fall upon their proper notes without arousing the consciousness.

To the young musician, such a mechanism is almost incomprehensible, and were he to attempt to illustrate this by his own efforts, he would find, firstly, a failure in his co-ordinative movements—his fingers would be slow to adapt themselves to the necessary intervals, through insufficient practice or ineptitude; secondly, sensations of resistance would be experienced, with an immediate stimulation or arousal of consciousness; and, thirdly, the results of long training in resolving discords, in weaving successions of notes or chords into rhythmical form would be wanting. Such considerations as these lead us to agree with Ziehen, that intercurrent stimuli may so modify and, so to speak, improve upon the fitness of our reflex acts, that some of the highest and most complicated of our actions may be termed automatic, inasmuch as they may be performed without the concomitance of conscious phenomena. The "response movements" of Goltz also bear out the same view, in that they are adapted to a definite purpose, and are able to overcome opposing obstacles. Ziehen claims that the first automatic movements to be met with in the animal series have been developed from reflex action through the agency of "natural selection." He believes that originally the amphibians which regularly avoided an obstacle suddenly placed in their way, thereby modifying their locomotor course, were just as numerous as those which did not. In the struggle for existence, however, the former had a decided advantage, for mechanisms situated below the cortex relieved the cerebrum of work, and other deeper nervous centres fittingly performed its functions. This fitting peculiarity was inherited, and constantly bred by transmission, while those animals which were less favourably constituted gradually died out.

The Functions of Nerves.—Our knowledge of the functions of nerves is no more advanced than that of nerve-cells. The various functions of nerve-fibres have been classified more or less according to the different effects produced by the conduction of nervous impulses along them. Thus we have the following classes:—(*a*) nerves of motion controlling the muscular apparatus, whether of smooth or of striated muscular fibres; (*b*) nerves of inhibition; (*c*) nerves of secretion; (*d*) trophic nerves, or nerves which have a direct influence upon nutrition; (*e*) centripetal nerves that have no sensory functions; and (*f*) sensory nerves, or those the excitation of which may result in conscious sensation.* With results so different as those seen in the above classes, we naturally ask ourselves whether those differences are due to variations in the modes of transmission of the impulse, or is the cause to be sought in the origin of the nerve-commotion? For the present we are quite unable to satisfy ourselves in this respect, since our knowledge of the nature of the impulse transmitted has been shown to be so extremely limited. Ladd says, "Just as the same electric current may pass along the same kind of wire, and write a message, or ring a bell, or move the legs of a frog; just so, the irritation of certain fibres of the pneumogastric nerve results in controlling the motion of the heart; the irritation of other nerves seems to have no immediate metabolic effect in directing the secretory

* Hermann, "Hanb. d. Physiol." II., i., p. 200 ff.

processes; that of still others profoundly modifies the nutrition of the portions of the body to which they are distributed."

A more convenient classification of the nerve function of conduction is that of *afferent* and *efferent*, according as the nerves in question serve as conductors of nerve-impulses inward toward, or outward from the nerve-centres. Some writers have supported the view that afferent and efferent nerves have the same specific mode of neural action; whilst others believe that their respective molecular processes are essentially different. Our knowledge as yet, however, will not warrant us in giving credence to either of these views. We assume that impulses are propagated somehow along a nerve-fibre: we assume that such impulses may undergo variations, or even in the case of sensory nerves be transmitted backwards; and we deem it possible that the transmission of impulses is attended with chemical change: but beyond this we must confess to being in a state of complete ignorance.

The *nature of a nerve-impulse* is assumed to be that of waves of molecular vibration or of chemical action, or of the two in combination. Schäfer holds, that there is absolutely no evidence of the first supposition, although the fact still remains that there is some evidence of chemical action. Upon the views of d'Arsonval—that the electrical phenomena of active muscle and nerve are produced by variations of surface-tension passing in a wave-like manner along the fibres—Schäfer conjectures that such waves of pressure, or surface-tension change, might possibly originate in consequence of the rhythmical contraction of the nerve-cell, or of any of its processes.

In illustration of this view Schäfer says,

"When a fibre of the pyramidal tract is excited, the nerve-impulses which are generated in that fibre, and which are probably of the same rate as the excitation, pass down to the grey matter of the spinal cord, and are there converted into nerve-impulses, which may have a very much less frequent rhythm. This can only, so far as appears, take place at the adjunction of the terminations of the pyramidal-tract fibres with the motor nerve-cells; and it would appear that the motor nerve-cell is stimulated by the nerve-impulses which are conveyed along the fibre of the pyramidal tract, but that it responds to that action with a very much slower rhythm than that of the assumed excitation; for the excitation may be as rapid as 100 per second, or more; but provided it is not too intense, the impulses which pass along the motor fibres are only at the rate, as shown by the response of the muscle, of about 10 per second. The same thing is seen when the muscles are made to contract by a reflex excitation of the skin. Such an excitation may be very rapid or it may even be continuous. This rapid or continuous excitation of the skin produces in the sensory fibre nerve-impulses, which may be assumed to be at least as rapid as the excitation itself, and these are conveyed to the grey matter of the lower nerve-centres, and are converted into nerve-impulses of a relatively slow rhythm, as shown by the rhythm of the reflex muscular response. This transformation may be assumed to occur either in the motor projection-cell, or in an intermediary cell, if any such intervene between the afferent fibre and the motor-cell, and the slow rhythm of the epileptiform convulsions which follow strong electrical excitation of the cerebral cortex, and which certainly originate in the cells of the cortex, furnishes another well-marked instance of rhythmic production of nerve-impulses by nerve-cells."

When we considered the anatomy of the nerve-cell and the ramification of its processes we said, that there was no direct continuity between the nerve-cells, except through the contiguity of those ramified processes. Schäfer has shown that, as a consequence, there is always a partial block to the passage of nerve-impulses at the conjunction of one cell with another, and he regards the period of time lost at this junction as representing the period of latent excitation of the nerve-cell. For an account of what probably happens at this point we cannot do better than again quote his own words :—

"The nerve-fibre to which the excitation is applied carries nerve-impulses, which become spread out in the fine arborescence, which forms the termination of that fibre and which enwraps the motor-cell. From this cell nerve-impulses start which are not necessarily of the same rate as those which have reached the terminal arborescence just mentioned, and these new nervous impulses pass down towards the muscle and cause its contraction. It is clear that a change occurs at the adjunction of the arborescence within the cell-body. A change in rhythm certainly occurs,* and this renders it extremely probable that the nerve-impulses which are passing off from the spinal cord are entirely new impulses. If so, we may look upon this cell as having been freshly stimulated by the impulses which have passed along the fibre of the pyramidal tract. We may briefly consider in what manner it can be thus stimulated. Since there is no evidence that the fibrils of the arborescence anywhere touch the cell-body or its processes, we must assume that a space intervenes everywhere between the two,

* "Journal of Physiology," 1886, vol. vii.

very narrow indeed, but still a space which cannot readily, if at all, be traversed by nerve-impulses. It is possible to suppose that the nerve-impulses reach the pericellular arborescence, and produce by mere induction new nervous impulses within the cell around which they play. But we have no evidence that such nerve-induction is possible. It is also open to us to suppose that the electrical change (action current), which accompanies the passage of the nerve-impulses to the arborescence, may itself be the excitant of the nerve-cell, and that the nerve-cell may respond to this excitation by a rhythmic chemical action, possibly molecular vibration, or perhaps a combination of two of these. At all events, it is probable that a new process is started within the nerve-cell. This does not necessarily follow from the fact that there is time lost at the adjunction, for a partial block to the passage of nerve-impulses and a resultant loss of time may be produced merely by mechanical means; but the change of rhythm renders it extremely probable."

The function of *conductivity of nervous impulses* varies considerably under certain modifying conditions. The velocity of transmission of an impulse along a human motor-nerve is estimated by Helmholtz and Baxt to be 100 to 120 feet per second. In visceral nerves it is somewhat less (26 feet, Chauveau). Both elevation and lowering of the temperature lessen it. Anelectrotonus also diminishes, while cathelectrotonus increases it. (Rutherford and Wundt).

Negative variation in nerve is readily observed if a nerve be placed with its transverse section on one non-polarisable electrode, and its longitudinal surface on the other; then, by stimulating it electrically, chemically, or mechanically, the nerve-current is found to be diminished (du Bois-Reymond). According to Bernstein, this negative variation is propagated towards both ends of a nerve, and is composed of very rapid, successive, periodic interruptions of the original current. The amount of the negative variation depends upon the extent of the primary deflection, the degree of nervous excitability, and on the strength of the stimulus employed.* Head found that it increased with the duration and strength of the stimulation, and with the drying of the nerve. The velocity with which negative variation is propagated, as estimated by means of the differential rheotome, is a subject of great interest, but its further consideration must be for the present deferred.

* Landois and Stirling, p. 559.

Do nerve-impulses pass backwards? It has been demonstrated by Gotch and Horsley* that impulses do pass down afferent or sensory paths, but no matter how strong the stimulus employed, they do not pass up the efferent or motor-paths. Schäfer offers an explanation of this in the anatomical arrangement of the terminations of the pyramidal tract fibres around the motor-cells, as compared with the mode of central termination of the sensory fibres within the grey matter. Such an arrangement, he conceives, may allow of the excitation of new nerve-impulses within the body of the motor-cell by an electrical discharge from the fine brush of pericellular fibrils which envelopes the body of the motor-cell; whilst the electrical change which accompanies nerve-impulses up the motor-fibre, when this is artificially stimulated, may be so diffused throughout the cell-body of the motor-cell, as to fail to stimulate and set up nerve-impulses in the pericellular ramification of fibrils, which represents the ending of the fibre of the pyramidal tract.

The most important fact which has been pointed out of late, is that cells and fibres may functionate by contact only. The observations of Golgi, Ramón y Cajal, and Kölliker seem to demonstrate that direct continuity of structure is not essential for the propagation of motor, sensory, and reflex excitations. Kölliker † has demonstrated the truth of this in the cases of sensory root-fibres, which end free in the grey matter of the cord and medulla, the terminations of lateral branches of the nerve-processes of many of the cells of the grey matter, and also the terminations of the longitudinal fibres and collaterals of the anterior and lateral pyramidal tracts in the grey matter of the anterior horns.

Intercellular Connections.—Ramón y Cajal ‡ holds the view, that not only may the protoplasmic prolongations of the nerve-cells possess nutritive functions, but, also, they may, as well as the body of the cell itself, serve as conductors of nervous currents between neighbouring cells and elements at a distance. From the minute study of the histological appearances of the connections of the olfactory nerve-fibres, and those

* "Phil. Trans.," 1891, vol. 182, B.

† "Anat. Anzeiger," 1891.

‡ "Croonian Lecture," Roy. Soc., March 8, 1894.

of the visual fibres and of the retinal cells, he drew the conclusion, that not only do the protoplasmic expansions act as conductors, but also that the nervous current is inward toward the cell in these expansions, and outwards from the cell in the axis-cylinder. The nerve-cell has, in the dendritic expansion and the cell-body, an apparatus for the reception of currents, an apparatus for transmission in the prolongation of the axis-cylinder, and an apparatus for repartition or distribution in the terminal nervous ramifications. From an analysis of the quantitative and qualitative difference which cerebral action presents among different animals and in the same animal species, Cajal regards the morphology of the pyramidal cell as but one of the anatomical conditions of thought. But he does not believe that this special morphology will ever suffice to explain the enormous differences which exist, from a functional point of view, between the pyramidal cell of a rabbit and that of a man, any more than between the pyramidal cell of the cerebral cortex and the stellate-cells of the cord or the great sympathetic.

From the fact that the nerve-elements lose their power of proliferating after the embryonic period, an increase in the number of cells is not to be looked for as an essential feature in the improvement of organisation of the brain. On the other hand, it is probable that, in those regions which are most exercised, mental activity involves a greater development of the protoplasmic apparatus, and of the system of collateral nervous paths. It is in this way, says Ramón y Cajal, that associations already in existence between certain groups of cells would be notably reinforced by means of the multiplication of the minute terminal branches of the protoplasmic expansions, and of the collateral nervous paths. Further, absolutely new intercellular connections might be established by the formation of new collateral connections and protoplasmic expansions. The anatomico-physiological hypothesis, which bases intellect upon the richness of the cellular association, is open to an objection, which, however, this author fully recognises. How can the volume of the brain be maintained unaltered if there be a multiplication, and even a new formation of the terminal branches of the protoplasmic appendices, and of the collateral nervous connection? In reply to this objection, he states there is nothing to prevent our supposing either a correlative diminution of the cell bodies, or a proportional shrinking of those parts of the brain whose functions are not directly related to the exercise of the intelligence. We may thus explain family talent by supposing an hereditary transmission to the immediate or, by atavism, to the more distant descendants of this superior organisation of the connections of the pyramidal cells. In the case of those men in whom talent is coincident with a brain of small size, the nerve-cells would be less numerous, or, perhaps, simply smaller; whereas, on the other hand, they would present a very complicated system of protoplasmic nervous associations. The excessively large brain, on the other hand, so often associated with defective intelligence, or even with imbecility, would contain a greater number of cells, but the connections between them would be very imperfect. As compared with the theory of networks, Cajal believes that the theory of the free branching of cellular expansions, capable of growth, is not only more probable but also more encouraging. "A continuous network," he says, "pre-established—a sort of fixed telegraphic grillwork into which it would not be possible to introduce either new stations or new lines—it is a thing so rigid, so immutable, so unmodifiable, that it does violence to the feeling which we all have, that the organ of thought is, within certain limits, plastic and susceptible of being improved, especially during the period of its development, by well-directed 'mental gymnastics.'" His comparison of the cerebral cortex to a garden containing innumerable trees (the pyramidal cells), which, in response to intelligent cultivation, can increase the number of their branches, strike their roots over a wider area, and produce ever more varied and more exquisite flowers and fruits, is open to criticism; and we shall see that mere quantitative variations in cerebral structures are not, in reality, sufficient to explain qualitative variations in mental events.

CHAPTER II.

Chemical Properties of Nerve-substance.

Specific Gravity—Percentage of Water—Albumin—Potash Albumin—Nuclein—Neuro-Keratin—Cholesterin—Cerebrin (Homocerebrin Encephalin)—Lecithin—Protagon.

Vascular Supply of the Brain.

Basal Arterial System—Anterior Cerebral Arteries—Middle Cerebral Arteries—Posterior Cerebral Arteries—Arterioles of the Cortex.

Lymphatic System of the Brain.

Regulation of Cerebral Pressure — Lymph-Cisterns — Perivascular Channels — Cerebro-Spinal Fluid — Pacchionian Granulations — Subarachnoid Space—Venous Circulation—Quantitative Relations between Blood and Cerebro-Spinal Fluid.

Brain-Movements.

Pulsatile — Respiratory — Vascular — Nutrition of Nerve-elements — Functional Hyperæmias—Vaso-motor Centres—Influence of the Sympathetic.

CHEMICAL PROPERTIES OF NERVE-SUBSTANCE.

When we begin to study the chemical and mechanical properties of nervous substance we find that the facts with which we have to deal are comparatively few in number, and their import uncertain. This is not to be wondered at when we remember that the nervous tissues are formed by highly complex and unstable compounds. Attempts have been made to estimate the chemical nature of the white and the grey nervous matter respectively, and they have been found to differ not only in chemical constitution but also in specific gravity. It must be remembered, however, that it is difficult to make an absolute distinction between the white and the grey substance, and more especially is this the case in investigations where facts can be obtained only by an examination of the entire masses of the brain. Meynert recommends his method of dissecting out the brain-trunk and cerebellum from the hemispheres as peculiarly adapted to such investigations, but no one seems to have adopted his suggestions, and our knowledge on this head is exceedingly fragmentary. Danilewski attempted to estimate the elements of the grey and the white substance by means of a comparison of the differences in their *specific gravity*. He found that the sp. gr. of the grey substance varied between 1·029 and 1·038, and that of the white substance between 1·039 and 1·043. In man, he found the relative proportions of both substances to be 37·7 to 39 per cent. of grey substance, and 61 to 62·3 per cent. of white substance; while in the dog, the grey and the white substance were present in equal proportions. Bastian, W. Krause, and L. Fischer estimated the mean sp. gr. of the grey matter at about 1·031, of the white at 1·036—1·040.* The explanation of this difference in weight is attributed to the relative amount of water and of solids which they contain. Gamgee † has given a tabular statement of Weisbach's investigations as to the *amount of water* entering into the composition of the different parts of the central nervous system. From this table the largest percentage of water is found in the grey substance of the brain (83 per cent. approximately). The cerebellum comes next with about 78·5 per cent.; then the medulla oblongata, 74·5; pons Varolii, 73·5; and the white substance of the brain about 70 per cent. The cortex contains 86 per cent.; the medullary substance of the hemisphere 70 per cent.; the oblongata 74 per cent.; sympathetic 64 per cent. Bernhardt found a smaller proportion of water in the cervical region of the cord (73·05 per cent.) than in the lumbar (76·04). Another fact ascertained from the results of Weisbach's observations is, that in man between the age of twenty and thirty there is a relatively

* Ladd, "Physiol. Psych.," p. 22.

† "Physiological Chemistry of the Animal Body," i. p. 445, London, 1880.

higher percentage of water than between the age of thirty to fifty; and, further, that between the age of seventy and ninety-four there is a higher percentage than at either of the former ages.

Observations are much wanted upon these points, and it is of importance to us to know under what conditions we are to expect an increase in the watery constituents, both in the normal and the morbid brain. At the present time our knowledge of the relative proportions of such an increase in general paralysis of the insane, and other progressive brain diseases, is, so far as I am aware, absolutely nil. Meynert regards the preponderance of grey substance in animals compared with the grey substance in man, as dependent upon the excess of amorphous connective tissue in the former. In man this substance is regarded as albuminous in character; hence Boll considers it allied to connective tissue, which, he claims, contains remnants of albumin derived from formative cells, and only differing from other connective tissue in the possession of a greater quantity of albumin. *Albumin* is found both in the axis-cylinder and in the substance of the ganglionic cells. Some of this proteid substance was formerly regarded as myosin, and presented characters not unlike those of this compound. We now know, however, from the experiments of Petrowsky, that this substance is insoluble in a 10 per cent. solution of sodium chloride. The dilute solution of this salt extracts a proteid from nervous matter, which is, however, precipitated by the addition of much water, and by a concentrated solution of the salt. *Potash albumin* and a *globulin-like substance* are also present.* Both Kühne and Ewald found, that if grey nervous matter was subjected to artificial digestion, by trypsin—the pancreas ferment—two substances remained undigested, *nuclein* and *neuro-keratin*. The latter being obtained by treating the residue with caustic potash.

The occurrence of nuclein in the grey matter is said to imply the presence of phosphorus in the ganglion-cells and axis-cylinders. But whether this substance (nuclein) is actually present in the brain at all is a matter of doubt. Von Jaksch and Drechsel believe that it does occur, but its existence has

* Landois and Stirling, p. 531.

been denied by Worm-Müller and Gamgee. The formula of this substance is given as $C_{29}H_{49}N_9P_3O_{22}$. Jaksch found an excess of nuclein in the grey substance as compared with the white. He did not, however, thoroughly isolate the grey substance. Geoghegan also found it in the proportion of 1·4 to every 1,000 parts of the entire cerebral mass. From the experiments of Meyer and Cornwinder—who proved that in plants the quantity of phosphorus increased in direct proportion to the quantity of nitrogen; and the researches of Bischoff, who found phosphoric acid in a definite proportion to the quantity of nitrogen in the urine of starving animals, whereas, the quantity of phosphorus taken in was greater than that in the excretions if the animal was properly fed—Voigt infers that the albuminates and phosphates unite, so that the fundamental connective tissue, as well as the nerve-cells in the grey substance of the brain, must be classified with those substances which contain phosphorus. In the chemical composition of the brain the element of phosphorus of the grey substance constitutes an important factor. Meynert, relying upon the observations of Schlossberger, Bibra, Pollak, and Jaksch, estimates that a fresh brain contains 0·49 per cent. of phosphoric acid in its grey substance, and 0·89 per cent. in its white substance. He says we are not warranted, however, in concluding that the nervous system contains an absolutely larger quantity of phosphorus. The quantity of phosphorus in the nervous system cannot be gauged by the amount of phosphorus in the excretions; for, as Voigt has determined, the entire nervous system of man contains but 12 grains of phosphoric acid as compared with 130 grains in the muscles, and 1·800 grains in the bones; and, besides, we know, ever since Chossat's starvation experiments were published, that during starvation the nervous system shows no appreciable loss of weight.

Neuro-keratin occurs in the corneous sheath of nerve-fibres. It is also found in the grey matter of the nerve-centres, and in the retinal epithelial cells and pigment cells of the choroid; but not in the non-medullated nerve-fibres. It is a body containing much sulphur, and is closely allied to keratin. It is soluble only in a hot concentrated solution of caustic potash and sulphuric acid, and amounts to but 15 or 20 per cent. of the dried residue of the alcoholic or ethereal extract of the brain. If the fatty matters of the medullary sheath are extracted with boiling alcohol and ether, this highly refractile substance is left as an irregular network.

Cholesterin ($C_{26}H_{44}O + H_2O$) is regarded as a monad alcohol which occurs in a free state, especially in white nervous substance. It is non-nitrogenous, taking the form of fine needles or rhombic tables when separated from its solution in ether or alcohol. Hoppe-Seyler says that this body is probably merely suspended, and not dissolved, in protoplasm; that it is common to all living vegetable and animal cells, taking no important part, however, in the development of the cells. It is uncertain whether it is, as maintained by Hoppe-Seyler, a product of decomposition resulting from the organic changes during cell life. Petrowski states that lecithin and cholesterin originate from the cells of the grey substance and not from the white substance mixed with it. According to Drechsel, the terms *lecithin*, *cholesterin*, and *cerebrin* designate mixtures only; of which lecithin applies to the phosphorised substance which has been dissolved by ether and alcohol; cholesterin to the ethereal extract which remains after removing the lecithin; and cerebrin to the substances which form crystals in hot alcohol, but are insoluble in cold alcohol (*v.* Meynert).

Cerebrin ($C_{69.08}H_{11.47}N_{2.13}$. Parcus) is a white powder composed of spherical granules soluble in hot alcohol and ether, but insoluble in cold water. It is prepared by rubbing up the brain into a thin fluid with baryta water. The separated coagulum is then separated with boiling alcohol (Müller). Parcus gave the name of *homocerebrin* to a substance which he separated from cerebrin, this substance being slightly more soluble in alcohol than cerebrin. He also found a "clyster-like" body, soluble in hot water, which he named *encephalin.*

Lecithin ($C_{44}H_{90}NPO_9$. Diakanow) occurs as a phosphorised organic compound in the matter of the brain, and from its decomposition products we obtain glycero-phosphoric acid and oleophosphoric acid. Lecithin is a salt of the base *neurin.** Gamgee believes that lecithin is only one of a group of bodies which possess a higher percentage of phosphorus than protagon. It is soluble in water and alcohol, and has been formed synthetically from glycol and trimethylamin.

Protagon ($C_{116}H_{241}N_4O_{22}P$) is regarded by its discoverer, Liebreich, to be the chief constituent of the brain. It contains N and P, and resembles cerebrin. This substance is considered by some observers to be the only well-established phosphorised proximate principle of the brain. Ladd believes it to be the best representative that chemistry can as yet present, of a scientific result upon which to base any attempt to point out definite relations between psychical activities and the chemical constitution of those complex phosphorised bodies which exist in the central nervous mechanism, and he regards it as highly probable that protagon is not a compound or mixture of cerebrin and lecithin. The controversy as to whether protagon is a definite ultimate chemical principle, or a mixture of lecithin and cerebrin, has attracted a considerable amount of attention. The former view has been upheld by Kühne, Blankendorf, and Gamgee, whilst Diakanow, Hoppe-Seyler, and Thudicum have advocated the latter.

From a physiological and psychological point of view considerable importance is attached to the discovery of the composition of these highly complex phosphorised substances. More recently Drechsel has discredited the view that protagon is merely a mixture, by pointing out that the atomic weights of lecithin and cerebrin do not suffice to make a mixture of the nature of protagon, and that a third substance would have to be shown to exist containing more nitrogen and less carbon. The power the medullary substance of the brain possesses of reducing osmic acid, and turning a black colour, is regarded by Meynert as an additional reason for the existence of a body like protagon. He recognises, however, that these peculiar qualities are common, also, to the myelin forms of protagon resulting from prolonged contact of protagon with

* Landois and Stirling, p. 331.

water. Diakanow contended, although apparently without proof, that protagon contained no phosphorus at all. Blankendorf, Gamgee, and Drechsel found that the percentage of phosphorus was constant in protagon, although it had been re-crystallised four or five times. The hygroscopical characters of lecithin and cerebrin have led Meynert to believe, that though lecithin and cerebrin (the latter a substance without phosphorus) exhibit the starch-like properties and myelin-like forms, there is not sufficient ground to doubt the formation of these substances from the protagon of the brain, but that their marked hygroscopical properties stand in broad contrast to the lack of such qualities in protagon. "If protagon were a mixture of cerebrin and lecithin it would be difficult to conceive how a non-hygroscopical body could result from the union of two hygroscopical bodies. It would be more natural to suppose that the hygroscopical properties were the result of the more elaborate methods by which cerebrin and lecithin are recognised as secondary brain constituents, while protagon, a primary brain substance, is obtained in advance of these."

From these brief considerations the student must not for one moment imagine that he possesses anything like an adequate knowledge of the chemical constitution of nervous substance. Thudicum* states, that a quantitative analysis of the brain involves at least three hundred quantitative determinations of definite bodies or compounds. Each of the four divisions of the brain, and each of the two varieties of tissue—the white and the grey—would thus require at least about fifty quantations for chemical characterisation. Our account must necessarily be limited, and we are compelled to refer the student to the comprehensive article by Thudicum, in "Tuke's Dictionary," for details of the group of inorganic principles which have been isolated from the brain; and we hope, with this author, that more attention may be given to this subject by those who make psychological medicine their especial study.

* "Tuke's Dict. Psych. Med.," vol. i. p. 152.

VASCULAR SUPPLY OF THE BRAIN.

Our knowledge in reference to the vascular supply of the brain has been rendered more accurate owing to the independent labours of Heubner and Duret. The entire arterial supply of the brain has been divided into two systems—viz., a *basal* and a *cortical arterial system.* Here, we shall have to deal more particularly with the latter, for a full description of the source and mode of arrangement of the basal system would be beyond our object.

From the *basal arterial system,* as represented by the circle of Willis, numerous small branches pass off nearly at right angles, and enter the ganglia near the base of the brain. These are called "terminal" or "end" arteries, because they do not anastomose with one another; nor do they anastomose with the vessels of the cortical arterial system. The *anterior cerebral* and the middle cerebral are the main arteries of the forebrain. The former supplies the superior frontal and anterior two-thirds of the middle frontal convolutions, and the upper extremity of the ascending frontal. It has four cortical branches. The first supplies the two internal orbital convolutions; the second is distributed, to the anterior extremity of the marginal convolutions, to the superior, and to the anterior portion of the middle frontal convolutions on the outer surface; the third passes to the inner surface of the hemisphere as far as the calloso-marginal fissure; whilst the fourth goes to the quadrate lobule, and also gives off a branch to the corpus callosum. On the median surface, the corpus callosum, and the entire region from the frontal apex to the sulcus occipitalis, receive their blood-supply from the anterior, median, and posterior internal branches of the anterior cerebral arteries. The *middle cerebral,* in addition to the numerous small vessels which pass through the foramina of the anterior perforated space to the corpus striatum, the two grey nuclei and lenticular nucleus, and to the posterior part of the nucleus caudatus, gives off from its main trunk, as it reaches the island of Reil, several branches. These branches, as given by Charcot, are as follows:—(1) the external frontal, supplying the inferior frontal convolution; (2) the ascending frontal to the region of the anterior cerebral convolution; (3) the ascending parietal to the posterior central convolution and the superior parietal lobule; (4) the parietal to the parietal convolutions; and (5) temporal arteries, which ramify over the first and second temporal convolutions.

The *posterior cerebral* artery gives off numerous branches in the posterior perforated spot, and others as it passes round the crus, both of which sets pass into the thalami optici, crura cerebri, and corpora quadrigemina. It has three cortical branches, one to the anterior part of the uncinate gyrus and its immediate vicinity; one to the posterior part of the uncinate gyrus, and the lower part of the temporo-sphenoidal lobe; and a third to the occipital lobe on its outer and inner surfaces.* From the distribution of the anterior, middle, and posterior cerebral arteries, we see that they determine the blood-supply to certain regions. Each main artery gives off secondary and tertiary branches. These tertiary branches, in their turn, give off numerous fine filaments, which, according to Duret, do not anastomose with one another, although a communication may take place, to a certain extent, between the branches of contiguous areas. Opinions differ considerably upon this question of anastomosis between the vessels of the cortical system. Heubner, basing his opinion upon the result of his injections, believes that there is a free anastomosis between the main vessels and also between the secondary branches of the vessels of the cortex, the anastomosis being effected through vessels not less than a millimetre in diameter. He does not believe that collateral compensation is effected solely through the circle of Willis. In consequence of this view, objection is taken to the statement that an artery supplies any definite region or convolution.

In support of Heubner's view, we have the fact, admitted by Charcot, that in certain cases of arterial obstruction by embolism or thrombosis, there is an exemption from softening,

* H. Duret, "Archives de Physiol.," 1874, and Heubner, "Centralblatt für die Med. Wissensch.," 1872.

which would point to the establishment of a collateral circulation.

Duret contends that such anastomoses are absent or extremely rare, and he maintains that it is only through the terminal filaments of the branchlets that communications occur. Such communications, however, he believes, may vary in number in different individuals. Cohnheim also maintains that there are no anastomoses between the larger branches of trunk arteries, but that all the cerebral arteries more or less resemble true terminal or end arteries, in that they only communicate with other vessels through their ultimate capillary loops. Meynert believes that the arteries supply definite nutritive areas, and that the influence of the derivative network is not as powerful as Heubner would have it; further, he regards, as of great importance in cerebral pathology, the fact that, as there is no derivative network beyond the circle of Willis, these arteries, because of their shortness, are under the more immediate influence of cardiac action, and are therefore more liable to rupture than the cortical arteries.

Arterioles of the Cortex.—In his monograph on the structure of the cerebral cortex (1868) Meynert showed that the cortex was supplied with a large number of arterioles from the broad expansion of pia. All these arterioles were about the same size, and entered adjacent portions of brain tissue. Each one, moreover, represented, to a certain degree, an independent circulatory area. His observations led him to the belief that in a mass of tissues, supplied by a smaller number of larger arterial branches, it would be quite impossible for differences of arterial blood-supply to exist simultaneously in adjacent portions of that tissue. From this he inferred that partial functional hyperæmia of separate cortical areas was readily permissible, and that the so-called cortical centres could be functionally hyperæmic at a time when the other cortical centres were functionally at rest. The blood-supply to the brain would in this way be determined by the functional hyperæmia of the areas which were in a state of activity. In the pia mater we have, then, main arteries with their branches. branchlets, and fine filaments. From the branchlets and filaments a great number of minute arterial twigs pass at right angles into the cortex. These are commonly known as nutrient arteries: they are very slender, and vary in length. The longer twigs pass through the grey matter into the white substance, where they approach the terminal twigs of the basal arterial system, but with which, however, they are said to have no communication. In their course they give off numerous fine offsets, which communicate with the capillary network of the shorter ultimate arterial twigs. These latter usually terminate in a capillary network within the grey matter itself. In cases of embolism or thrombosis, therefore,

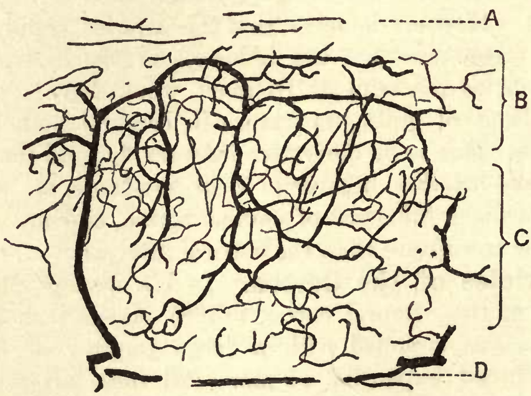

FIG. 6.

INJECTED CEREBELLUM OF CAT, SHOWING CORTICAL ARRANGEMENT OF BLOOD-VESSELS.

A, inner granule layer; B, layer of corpuscles of Purkinje; C, external layer; D, vessels of pia mater.

not only does the grey matter of the cortex suffer, but also the subjacent white matter, the amount of destruction, of course, depending upon the size of the vessel obstructed, and the amount of communication existing between it and its neighbours.

Meynert states that the larger branches of the arteries, on the surface of the brain, do not lie within the pia, but in the subarachnoidal spaces; the smaller branches only entering the pia. The general relations between the blood-vessels of the brain and the membranes is, as we shall see, a question of importance, as bearing upon the mechanism of nutrition. Before entering, however, upon this question, we must consider some other anatomical and physiological conditions, which have a direct bearing upon the quantity and quality of the cerebral blood-supply.

FIG. 7.

SHORT NUTRIENT ARTERY OF CORTEX CEREBRI, SHOWING CAPILLARY NETWORK.

A, pia mater; B, white matter.

Structure of the Cerebral Arteries.—The cerebral arteries have less muscular element than those of the body generally. In the larger arteries the *tunica adventitia* is directly continuous with the pia mater; whilst, in the smaller vessels, this sheath becomes an extremely fine membranous investment, either structureless or faintly striated, and with nucleated connective-tissue corpuscles upon it. The nuclei of these corpuscles proliferate readily. In some conditions ampullar dilatations are prone to occur. These dilatations are regarded by Bevan Lewis as being due to separation of the adventitial sheath from the tunica media, and a space between the two coats is to be seen at all times in the angle formed by the bifurcation of the vessel.

The vessels of the cortex lie in channels—the *perivascular channels of His*—which are continuous with the epicerebral space. Numerous delicate fibrillar processes, which arise from the stellate cells of the cortex, traverse this perivascular space, and form connections with the arterial sheath (Bevan Lewis). The capillaries of the cortex are of extremely fine calibre (not over 4μ in diameter, and of less calibre than the red blood-corpuscles). Bevan Lewis says, however, that we must allow for possible shrinking of the vessel by emptying its channel, as well as for the constricting effects of reagents, and that we can scarcely conclude that even these minute ramifications do not permit the passage of the red corpuscle. The same author makes the following observations upon the structure of the capillaries :—

"The only constituents of the arterial tunics, which enter into the structure of the capillary, are the endothelial layer or intima and the adventitial investment. In fact, the transition from the smallest artery

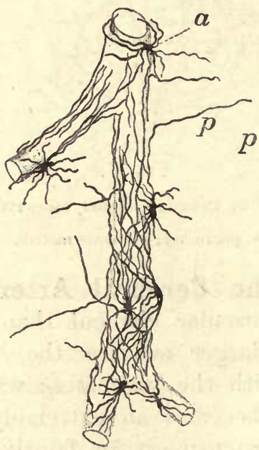

FIG. 8.

Blood-Vessel of the Human Brain, showing several Neuroglia Fibre-Cells surrounding it and forming a Felt-work (Perivascular System).

a, An encircling cell ; *p*, perpendicular neuroglia fibre entering the sheath at right angles from a distant (extrinsic) cell (Golgi's method).—(*Andriezen.*)

into the larger capillary is indicated by the disappearance of the muscular fibre-cell, and the continuation of the channel as an apparently homogeneous tubular membrane, with oval nuclei along its course, and here and there nucleated connective cells as the sole representative of the adventitial sheath. The intima, which is a direct continuation of the endothelial lining of the arteries, and by many believed to be the *only* constituent of the capillary, resembles that lining in every particular, save the number and form of its squamous cells. These are not only fewer, being often reduced to two in a transverse view of the vessel or its lumen; but instead of being polygonal, are more often elongated into fusiform plates.

"In the smaller capillaries the delicacy of the structure is such that it is at first often overlooked until its course is noticed, mapped out by short, narrow, spindle-shaped nuclei, arranged alternately at regular distances on the opposite sides of the vessel. In the same direction also will be found *rounded* nuclei, staining readily with aniline blue-

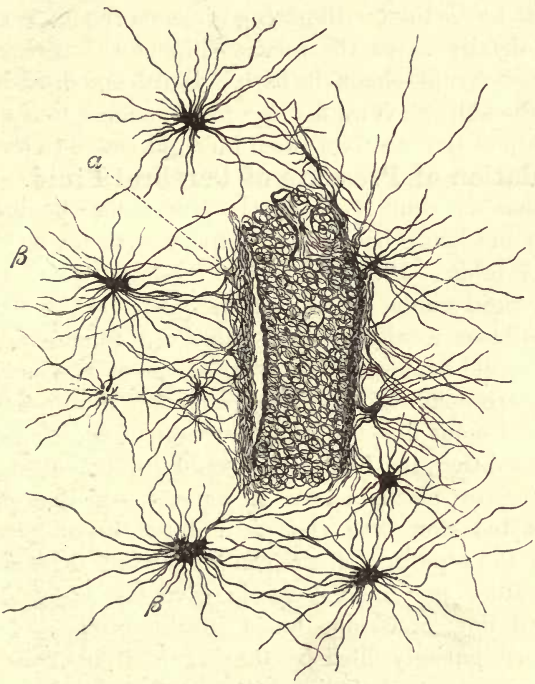

FIG. 9.

STRUCTURE OF LARGE VESSEL, SHOWING PERIVASCULAR FELT-WORK OF NEUROGLIA FIBRES.

Dense on the right side, less dense on the left side *a*, where it is distinctly separated from the blood-vessel by a space; *β*, extrinsic cells (Human Brain, Golgi's Method).—(*Andriezen*, "Internat. Monatsch. für Anat. u. Phys.," 1893, Bd. x., Heft. ii.)

black, sometimes aggregated into groups or arranged in linear series at very irregular intervals along the vessel. These are the derivatives of the adventitial sheath, and are, therefore, always external to, and placed upon, the *fusiform* nuclei. They are often the best guide to the direction of the capillary loops around the nerve-cell."

THE LYMPHATIC SYSTEM.

To the study of the lymphatic system of the brain considerable importance is attached, and our knowledge upon this difficult subject may be attributed chiefly to the labours of Obersteiner, Key, Retzius, Schwalbe, Meynert, and Bevan Lewis. Obersteiner was the first to define the nature and connections of the lymph-channels in the brain; whilst Bevan Lewis is to be credited with having given us the latest and most advanced details as to the relationship of the cortical nerve-cells to these lymph-channels, both in health and disease. It will simplify the subject, if we diverge for a moment to consider the relationship of the cranium, with its rigid walls, to the brain.

Regulation of Pressure of Cerebral Fluid.—Meynert believes that the skull regulates the pressure of the fluid within its cavity, and hence becomes an important factor in the nutrition of the brain. He states that if the brain were surrounded merely by rigid cranial walls, a partial change in the distribution of arterial blood would be conceivable. A functional increase, however, would be possible only upon one of two conditions—viz., a corresponding collateral arterial diminution, or a transfer of venous blood in the direction of the sinuses. For the first condition, he thought it would be difficult to explain an appropriate mechanism. A venous transfer would be altogether too slow, and there could not be any continuous action, for the repulsion of the venous current, dependent upon the respiratory movements, would give rise to a frequently interrupted flow of venous blood in the brain. The cranial cavity is not entirely filled by the brain; it includes, in addition, a number of spaces filled with lymphatic fluid. The dura mater is separated from the arachnoid by a comparatively small space, which is lined by endothelium. This space communicates with the lymphatic glands of the neck, and with the subdural spaces which do not immediately surround the nerve-roots, but do so in common with the arachnoid, and are connected with the lymphatic spaces of peripheral nerves.* As an example, we have the communication between the auditory labyrinth and the subdural space through the spaces which

* Meynert, "Psychiatry," p. 218.

surround the auditory nerve. In the tissue of the dura itself there are also lymph-spaces which are connected with the subdural space.

Lymph-Cisterns.—The explanation of the formation of the so-called "cisterns" is to be found in the relationship of the arachnoid membrane to the pia. They are connected by means of a network of threads and trabeculæ of connective tissue, and at the base of the brain by means of perforated membranes. At the summit of the convolutions the threads of this network are narrower than over the sulci; whilst, at the base of the brain where the subarachnoidal spaces are dilated, there may be no trabeculæ. Meynert enumerates the following cisterns which belong to the surface of the cortex:—

"The space of the *fossa Sylvii,* which is merely spanned by the arachnoid, and a space which separates it from the dorsal surface of the corpus callosum, which space extends on the basilar surface as far as the *linea terminalis* (of the central grey substance) situated beneath the corpus callosum. Farther back on the basilar surface we come upon the *cysterna chiasmatis* and the *cysterna intercruralis,* the latter dividing again into a superficial and a deep reservoir. From the *cysterna intercruralis* and to the outer side wide subarachnoidal spaces extend across the crus cerebri to the corpora quadrigemina—*i.e.,* from the basilar surface to the dorsal surface of the trunk, the *cysterna ambiens.* Short trabeculæ unite the subarachnoidal space just over the corpora quadrigemina to the surface of the latter. The most extensive subarachnoidal space on the dorsal side is the *cysterna magna cerebello-medularis,* extending from the dorsal surface of the oblongata to the cerebellum, on the superior surface of which exactly the same relations obtain as over the convolutions of the cerebrum.

"Behind the corpora quadrigemina, the arachnoid of the *cysterna ambiens* ascends to the upper wall of the *cysterna corporis callosi.* The flexion of the cerebellum over the oblongata produces, furthermore, a fold in the pia on its way from the cerebellum to the oblongata, the two laminæ of this fold giving rise to the *tela choroidea* of the fourth ventricle. The foramen Magendie leads through the pia from this ventricle into the subarachnoidal space of the spinal canal. In regard to the third ventricle, it is to be remarked that its membranous tela does not correspond to the superior wall of the primary cerebral vesicle, but that the only vestiges of this which remain are the epithelial cells of the plexus choroideus, at the lateral margin and on the inferior surface of the velum."

In the brain-cortex all the vessels are inclosed within channels, known as the *perivascular channels of His.* These channels are noticeable in hardened sections, and most markedly so in cases of atrophy of the cortex. Bevan Lewis differs from several authors in that he believes they are not the lymph-channels proper, but simply channels in the brain-substance, without an endothelial lining, and having free communication with the epicerebral space. He says these channels appear to be equivalent to an *involution of the naked surface* of the brain, and yet the epithelial elements of the epicerebral surface are not continuous along this tubular canal. Their appearance of being lined by endothelial cells is said to be due to the adventitial sheath of the blood-vessels, which becomes "closely appressed" to its limiting channel. The nerve-cell has around it a somewhat similar space, which Bevan Lewis has termed the *pericellular sac*, and he regards these as genuine sacs, and not mere artificial gaps in the brain-substance.* The perivascular channels and pericellular sacs communicate with the perivascular lymph-spaces of the adventitia. The study of the lymph connective system is of great importance in cerebral pathology; but it is yet to be shown how the individual elements of this system undergo morbid changes and cause alterations in the movements of the lymph. Bevan Lewis has summarised his account as follows:—

"The lymphatic system of the brain consists of—

"(1) A distensible lymphatic sheath, loosely applied around the arterioles and venules, containing numerous nucleated cells in its texture—the *adventitial lymph-sheath*—the whole being included within a non-distensible channel of the brain-substance, devoid of endothelial lining—the *perivascular channel of His.*

"(2) A continuation of the cellular elements of this sheath, loosely applied to the arterio-capillary plexuses, still contained within a perivascular channel, which now exhibit along the capillary loop sac-like dilatations—the *pericellular sacs,* within which the nerve-cell lies, surrounded by plasma.

"(3) A system of plasmatic cells with numerous prolongations, which are always in intimate connection with the adventitial lymph-sheath, and which drain the areas between the vascular branches—termed the *lymph connective elements.*

"Finally, if we take a comprehensive view of the whole system, the channelled vascular tracts, the saccular ampullæ along the capillary tube, the canalicular-like formation of the lymph-connective elements, all

* Bevan Lewis, "Mental Diseases," p. 823.

embedded in a homogeneous matrix of neuroglia, we cannot but be struck by the sponge-like arrangement of the cortex, and the facilities so offered for the free circulation of plasma throughout its most intimate regions."

Cerebro-Spinal Fluid.—The cerebro-spinal fluid in the brain is secreted by the epithelium of the choroid plexuses in the lateral, the third, and the fourth ventricles, and, possibly, from the general epithelial linings of these cavities. The fluid is transparent, and has a specific gravity of about 1010. The view that the lymph-cisterns act as a water cushion to minimise the shock to the brain and to compensate variations in blood-pressure, is supported by the fact that, in cases of spina bifida, the cerebro-spinal fluid can be readily driven from the spinal canal into the cranial cavity by pressure on the tumour, so that it may be assumed that a passage may be as readily effected in the reverse direction (Bruce).* Before entering upon a description of the various brain-movements, it would, perhaps, be well to consider briefly some points in regard to the Pacchionian granulations.

Pacchionian Granulations.—Meynert looks upon these bodies as prolongations of the subarachnoidal spaces. They occur in the course of all sinuses, but more particularly alongside of the *sinus longitudinalis.* The cerebro-spinal fluid is removed from the subarachnoidal space by several channels. Much of it passes into the corresponding space round the spinal cord, and escapes outwards along the subarachnoidal sheath of the spinal nerves. The remainder passes along the corresponding sheaths of the cranial nerves, or is excreted by the Pacchionian bodies into the superior longitudinal sinus in the dura mater (Bruce).

The *subarachnoidal space* is to be regarded as a true serous cavity, or lymph-space. Langer describes the sinuses, and the veins adjacent to them, as situated in the substance of the dura, and arranged in such a manner that the veins of the anterior portions of the hemispheres meet with the veins of the posterior lobes in the walls of the sinus longitudinalis, as though the former (veins) stood in the relation of *vasa vasorum* to the latter.

* "Tuke's Dict. Psych. Med.," p. 172.

Meynert has shown that a definite brain-pressure forces the serous fluid from the subarachnoidal space into the subdural spaces, whence, by a process of filtration, it empties into the veins and sinuses.

"The posterior cerebral veins take a similar longitudinal course forward, between the layers of the dura, so that the cerebral veins empty into the sinus for a distance of only 2 c.m., and about below the middle of the parietal vertex. The Pacchionian formations push forward into the cerebral veins as diverticula of the subarachnoidal spaces. The veins lie intradural, and the subarachnoidal spaces are shut off from the subdural space.

"The subarachnoidal spaces communicate, moreover, with the lymph-channels of the peripheral nerves, which encircle the roots, as does the dura also. From these subarachnoidal spaces we can throw injecting fluid into the lymph-space surrounding the optic nerve, into the peri-lymphatic space of the labyrinth, and the lymphatic vessels of the nasal mucous membranes."

The **venous circulation** within the cranium presents several peculiar features. The blood flows along the longitudinal sinus towards the occiput, and hence its course is opposed in direction to the blood issuing from the cortical veins, which open into the sinus in a forward direction. Hence the fact, that the blood which enters the brain by ascending arteries reaches the sinuses by ascending veins, is made use of to explain the occurrence of thrombosis in these vessels—the explanation being, that here gravitation is opposed to the flow of blood. In this way, morbid processes affecting the scalp—such as erysipelas, caries, or carbuncle—may readily affect intracranial structures by means of the communication with intracranial veins—*e.g.*, those of the nose, the facial through the ophthalmic, the mastoid veins, and the veins of the diploœ. Cerebral anæmia is sometimes produced, owing to hydrostatic causes—*e.g.*, if a person who has been in bed for a long time and whose blood is small in amount, be suddenly raised into the erect position. Such a condition is also not infrequently attended by loss of consciousness. Liebermeister regards the thyroid gland as a collateral blood-reservoir, which empties its blood towards the head during such changes of the position of the body.

Quantitative Relation between Blood and Cerebro-Spinal Fluid.—There is an intimate relation between the amounts of cerebro-spinal fluid and blood within the cranial cavity. When more blood passes in, some cerebro-spinal fluid passes out, and *vice versâ*. Formerly it was taught that, as the skull is a rigid box, and as the brain-substance and its fluids are practically incompressible, no variation in the amount of blood in the brain could be possible. This, however, is now proved to be erroneous. The average quantity of cerebro-spinal fluid within the cranium is about two ounces, and if it be suddenly withdrawn, epilepsy or convulsions may be produced; or, if it be rapidly increased in amount, coma may result. This fluid has also important mechanical functions, protecting delicate parts of the brain from injury, and by distributing vibratory impulses it insulates the nerve-roots. The presence of the cerebro-spinal fluid is, as pointed out by Donders, of great importance in regulating the pressure uniformly when brain-movements occur, so that every systolic and expiratory dilatation of the blood-vessels is concentrated upon those parts of the cerebral membrane which do not offer any resistance. These movements almost disappear when the fluid is abstracted.

The *foveæ glandulares*, according to Langer and Trollard, are venous, cavernous spaces produced by the wearing away of the vitrea, and are to be found in drunkards, in the senile, and in the subjects of heart disease. They are not, says Meynert, direct impressions of the Pacchionian dilatations of the sub-arachnoidal spaces. Meyer regarded their life as compensatory, inasmuch as they dilate with anæmia and collapse when there is a full current of blood within the brain. The increase and diminution of the amount of blood and cerebro-spinal fluid within the cranial cavity, is a question of great importance as bearing upon the nutrition of the brain; and it is by means of the orderly working of this mechanism that waste products are transferred from the circulation to the lymph-vessels.

BRAIN-MOVEMENTS.

The movements of the brain are of three different kinds:—(*a*) *pulsatile* movements communicated from the pulsations of the large basal cerebral vessels; (*b*) *respiratory* movements, so that the brain rises during respiration and falls during inspiration; and (*c*) *vascular* elevation and depressions which alternate, and are due to periodic dilatation and contraction of the blood-vessels. This last is a peristaltic arterial movement, regulated by the vaso-motor centre, and occurring from two to six times per minute (Meynert). These movements have been investigated chiefly over the fontanelles of children, and where the membranes have been exposed by trephining. Burckhardt's observations were made upon four patients with defective skulls. The peristaltic movements of the arteries dependent upon the vaso-motor centre are believed by Hering and others to be the result of the respiration of the vaso-motor centre itself. These movements are common to blood-vessels everywhere throughout the body, but, according to Hering, the stimuli causing such contractions do not always accumulate sufficiently to exert an influence with every respiratory act; in which case the rhythm of the movement is altered by other influences acting upon the vaso-motor centre by stimulation of the sensory nerves. In the case of the brain, which is surrounded by rigid cranial walls, and by the arachnoidal spaces, and from the fact that it is placed under considerable pressure, Meynert believes a modification of this general vascular movement is effected. The vascular wave, according to Mosso, is independent of the pulse and respiratory waves; but it may exert an influence upon the respiratory and pulse waves. The advance of the peristaltic wave within the rigid cranial walls aids in the establishment of currents of brain fluid, whereby metabolic waste products are carried off through the lymphatic fluids. The brain and the fluid surrounding it are subjected to a certain mean pressure, which depends upon the blood-pressure within the vascular system. Naunyn and Schreiber showed that cerebral pressure must be slightly less than the pressure within the carotid before the symptoms proper to pressure on the brain occur. The vascular wave causes a hemispherical protrusion of the cerebral mass, followed by a bowl-shaped contraction. The height and length of this wave are not equal. The wave flattens in a cool bath, and it is raised in a warm bath. It is most distinct and regular during sleep; during the hours of waking its regularity is interfered with. Moderately warm baths of 77-79° Fahr. lessen the number of waves, but make each wave longer; warm baths increase the number and shorten the single waves (Meynert). In one of Burckhardt's patients a sudden fright, followed by an unexpected noise, caused a rapid rise in the curve, followed by a fall. Whilst another patient was playing at chess low but long extended waves, with a few larger perturbations, were noted. He also found that while doing arithmetical work elevations were noticeable at the beginning and at the end, whilst in between depressions were more frequent. Meynert concludes, that all stimuli acting upon the sensorium create vascular movements, and disturb the periodic changes in the condition of the vessels; and that, of the psychical influences which may cause elevation, the emotions act more readily, and bring about a greater change than purely intellectual processes.

Great variations of brain-pressure are almost constantly attended by symptoms of disturbances of the nutrition of the brain. If the pressure is moderate the symptoms may remain latent, or only show themselves as headache, vertigo, weakness, or disturbance of the sensory functions. During sleep the circulation of the lymphatic fluid in the brain effects the removal of the waste products, and this, to a great extent, is dependent upon the vascular movements of the brain. Burckhardt regards the influence of this vascular wave as far more powerful than that of the respiratory wave: the irregularities of vascular wave-movements, which occur when the individual is awake, indicate that in certain parts of the brain there is an independence of action, just as we know to be the case in reflex arterial constrictions on the surface of the body.

Let us now consider the so-called "*pulsatory movements*" of the brain. From the circle of Willis the arteries ascend and their currents are directed upwards, as is also the case with the venous currents. The arteries at the base are the first to enlarge with the blood-flow; then the wave passes into all the branches of the vessels. The brain, however, is only able to enlarge concentrically toward the ventricles, on account of the resistance offered by the roof of the skull to the swelling of the convolutions. This concentric swelling of the brain is almost constant, and the pressure is neutralised in the ventricles in part by the circumstance, that, with the increased pressure arising from the flow of blood through the shorter arteries of supply to the basal portion of the ventricles, there is first an equivalent displacement of the cerebro-spinal fluid within the ventricles; then, when the engorgement of the walls of the ventricles diminishes, the blood-supply through the longer arteries to the cortex is forced by the cranial walls downwards toward the dorsal aspect of the ventricles. In this way less active movement of the cerebro-spinal fluid is brought about than if the basal and dorsal aspects of the ventricles were engorged simultaneously. The cerebro-spinal fluid finds its way through the foramen of Magendie, and to all the cisterns in general, so that the concentric pressure influences not only the contents of the ventricles, but also all the lymph-spaces. Meynert also points out that the engorged parenchymatous arteries effect the exudation of lymphatic fluid from those perivascular spaces which lie between the blood-vessels and the adventitia, so that the systolic pressure is still further neutralised. Coincidental with the basilar constriction the upper parts of the brain are pressed against the cranial roof, and with the increased pressure within these parts resistance is offered to the advance of basilar cerebral fluid. In addition to the escape of fluid through the foramen of Magendie, during the first phase of the vascular systole, a certain amount flows into the veins of the choroid plexus. With the systole of the superior cerebral arteries, we have the simultaneous occurrence of the basal diastole; but the displaced cerebral fluid does not now return to the ventricle. In consequence of the swelling of the basal portion, the diastole pushes the fluid past the upper cerebral parts (which have been removed to a distance from the skull by the arterial systole) into the Pacchionian bodies and the sinuses, and then into the basilar nerve-sheaths and into the cervical glands. The return of the ventricular fluid is still further prevented by the increase of ventricular fluid secreted by the choroid arteries during their diastolic dilatation. Quinke injected cinnabar into the spinal subarachnoidal spaces, and found that the greater portion penetrated as far as the Pacchionian glands, the dura, the sheaths of the cerebral nerves, and to the cervical glands, but not to the ventricles, or perivascular spaces between the pia and media of the arteries. The explanation of this, as offered by Burckhardt is, that, if an artery, lying in the midst of a perivascular space which communicates with the subarachnoidal spaces, contracts, lymphatic fluid will pass from the parenchyma into the perivascular space (in a direction opposed to the course of the injection from the cerebral surface into the perivascular space), because the passage to the subarachnoidal spaces on the convexity of the brain is now unobstructed; but if this artery in the perivascular space be dilated, it obstructs this passage by filling out the above space, and no cinnabar will be allowed to enter the subarachnoidal spaces. During this stage the lymph-current is impelled toward the veins, as by the pulse wave, which, with less success during cardiac systole, enables parenchymatous lymph-fluid to be absorbed by the veins, and, during cardiac diastole, opens up the passage into the subarachnoidal spaces.

The act of inspiration causes a fall, whilst that of expiration causes an elevation of the pulse-wave. This influence is most noticeable during forced efforts of expiration, and depends upon variations in the venous pressure. This venous pressure acts retrogressively upon the cerebral venous sinuses. Starting from the *torcular*, the stasis occurs first in the longitudinal sinus, and the comparatively short sinus rectus; hence the veins of the cortex are sooner affected than the longer veins of the choroidal plexus. As the result of this venous pressure, concentric swelling of the hemispheres occurs, although less frequently than was the case with the pulse-wave; the venous pressure also acts from the vertex downward, instead of from the base upward, as does the pulse-wave. From these brief considerations of the arterial supply, the movements of the brain during systole and diastole, and the movements of the cerebro-spinal fluid, we can gain some idea as to the mechanism of nutrition of the brain; but as yet we know little or nothing of the modes of nutrition of the individual nervous elements, and it is to this part of our subject that we must now pay attention.

Nutrition of Nerve-Elements.—The fact that, when motor or sensory nerves are cut, they begin to die at their central or peripheral ends respectively, suggests to us the presence of some mode of nutrition other than that dependent upon the plasma of the blood. This other condition is found in the influence of stimulation and conduction. The non-medullated tissue of the axis-cylinder exercises a strong attraction for nutritive plasma, but this is rendered more effective by the mediation of stimulation. During the processes of stimulation and conduction the axis-cylinder is better able to attract nutrition from the plasma, and to increase the chemical changes involved by the intensity of the nerve-current. The sheath of the axis-cylinder, consisting, as it does, of horny and glutinous substances, has been compared by Meynert to a sieve, which allows the nutritive plasma, as much of it at least as is attracted from the white substance, to fall upon the axis-cylinder, not with the intensity of a full current, but with the more delicate force of rain; and we must regard the partial endosmotic permeability of the neuro-keratin sheath as an apparatus regulating the physiological needs of the axis-cylinder. Rumpf has shown that the nutrition of the axis-cylinder depends in part upon stimuli, and therefore upon the axis-cylinder's connections with a peripheral sense organ and a central organ. In the brain there is a larger proportion of water than in nerve-fibres generally, and possibly this fact has some relation to the lessened tension (through absence of the sheath of Schwann), and consequent greater exudation of plasma. Owing to the denser supply of blood-vessels to the cortex there is also a relatively larger supply of plasma to the axis-cylinder. In the grey substance generally, there is a larger percentage of water than in the white, and the nutrition of the former is almost entirely dependent upon its blood-supply; thus, in this way, it differs somewhat from the indirect and independent mode of nutrition of the axis-cylinder.

The nerve-cell is also surrounded by a perforated keratin-sheath which regulates its supply of nutritive plasma. In the grey substance of the cortex there is less danger of suffering from anæmia than elsewhere. This is to be accounted for by the independence of the ganglion-cells and the axis-cylinder, which, under the influence of attraction, stimulation, and conduction, are rendered, to a certain extent, safe from vascular disturbances. The nutritive function of the nucleus over the albuminoid substance, is insisted upon by Meynert, who also infers a direct relation between albuminoid substances and the percentage of phosphorus. The influence of the nucleus upon the nutrition of the cell has already been alluded to; and as nuclein contains a relatively large proportion of phosphorus, its influence by some is regarded as of importance, especially in the regeneration of tissues in pathological processes.

In order that we may be better able to understand the mechanism of the so-called "*functional hyperæmias*" of the brain, we must return to the consideration of some anatomical and physiological condition of the cerebral mechanism, upon the efficiency of which the nutritive processes of the brain in great part depend.

The **vaso-motor centre** is looked upon as the chief centre which supplies all the non-striped muscles of the arterial system with motor nerves, termed "vaso-motor," "vaso-constrictor," and "vaso-hypertonic" nerves. Under ordinary conditions this vaso-motor centre is in a condition of moderate rhythmical tonic activity. When this area is stimulated there occurs a general increase of arterial blood-pressure through contraction of all the arteries. Paralysis, on the other hand, causes a fall of blood-pressure through relaxation and dilatation of all the blood-vessels. This centre can be excited directly or reflexly. It shares also, with some other centres in the medulla oblongata, the functions of dominating or controlling similar centres placed elsewhere. The assumption that there is a continuous, regulating, and inhibitory action of this centre upon the heart through the fibres of the vagus, is, according to Bernstein, not, in reality, sufficient, for there is a reflex condition effected through the abdominal and cervical sympathetic. All the three cervical sympathetic ganglia, in some degree, supply vaso-motor power to the spinal cord and brain. The superior cervical ganglion, by its connection with the lenticular ganglion, has power over the movements of the iris; by its association with other cranial nerves it takes part in the secretion of saliva, tears, nasal, and pharyngeal mucus; it supplies vaso-motor fibres to the external carotid and its branches; it also sends branches to the internal carotid which it follows within the skull, innervating the dura mater, the vessels of the anterior and middle brain, both basal ganglia and cortex, the latter through the vessels of the pia mater. It is not yet definitely known whether this superior cervical ganglion is the only vaso-motor centre for these portions of the brain, or only the chief one. When there is ablation of this ganglion, vaso-motor influence may gradually be supplied by nerves from the cervical plexus, by fibres from the pons, medulla oblongata, and upper part of the cord. The middle cervical ganglion supplies vaso-motors to the thyroid gland, and to the larynx and part of the trachea. The inferior ganglion supplies vaso-motors to the vertebral and basilar arteries and their branches.*

It has not yet been proved how far we may regard the cortex as possessing vaso-motor centres. With arterial systole we have vaso-constrictor influence, and with the arterial diastole we have vaso-dilator influence at work; but, as pointed out by Meynert, mental processes are not interrupted by arterial systole; therefore they must, to a certain degree, be independent of functional hyperæmia. Meynert thinks that this independence of mental acts may possibly be due to the fact that the cortex itself acts as a vaso-motor centre in its relations to subcortical centres; and, arguing from the evidence of the influence of cerebral activity over the vaso-motor centre, he concludes that the vaso-motor nerves of the cortex do not reach the blood-vessels at once, but that they are interrupted in the subcortical vaso-motor centre; and that these subcortical centres must be constantly in a state of activity for the vascular innervation of the cortex.

Every sympathetic ganglion is a vaso-motor centre, possessing some independence of action, but more or less controlled by a higher ganglion of this extensive system. The vaso-motor nerves of the cranium come from the cervical sympathetic ganglia, and are arranged in two plexuses in the vessels of the brain—one in the external tunic, and one in the middle tunic of the artery. The veins, possessing less muscular tissue, receive fewer nerve-filaments. Whether the nerve-filaments terminate outside the muscular elements, as maintained by Krause, or penetrate into the interior of the smooth fibres, as believed by Henocque and Arnold, is a problem which we are not prepared to solve. The terminal fibres of these small plexuses of the arteries end by punctiform swellings in the

* Long Fox, "Influence of the Sympathetic on Disease," p. 13.

nucleus, or in the fibre; or extend along the interstices of the fibre cells. In the veins their terminations are similar; and in the capillaries the fibrils probably end in the nuclei of their walls. Some ganglion-cells are interposed in a bundle of sympathetic nerve-fibres; others have prolongations of their substance on the axis-cylinder of the nerve-fibre. A partial independence of these sympathetic ganglia is manifested in various phenomena—viz., (*a*) nutrition may be carried on in spite of destruction of the cerebro-spinal centres, supporting the view of Goltz, that local centres are able to maintain the tone of arteries within their own immediate vicinity; (*b*) reflex irritation of vaso-motor nerves may be limited to the particular tissue supplied, as seen in the continuance of the heart's action after its separation from the body; (*c*) vaso-motor neuroses of the extremities; automatic and reflex co-ordinate movements and secretions are known to occur apart from the influence of the cerebro-spinal centres; (*d*) the stimulus of the blood itself acts reflexly upon vascular tone, and the phenomena of blushing, and local hyperæmias further indicate the partial independence. When we consider the partial independence in the action of this complicated sympathetic system, and the dependence of action brought about by association with the cerebro-spinal system, we readily appreciate the dictum that, "The use of the central cord of the sympathetic is to make the animal and the vegetative worlds known to each other, so that revictualling should be disproportionate to waste."* The independence of the vaso-motor portion of the sympathetic is also shown in many conditions of shock or injury to this system. Woakes has pointed out the relation between injury of the nerves of the brachial plexus and loss of consciousness, the resulting shock of the former being propagated to the inferior cervical ganglion, and thence to the vertebral artery, and all its branches. We can state, therefore, that, under certain conditions, sympathetic ganglia may act as independent centres for reflex acts. The importance of this fact, in the production of variations in the vaso-motor conditions in the brain, cannot be over-estimated,

* Fox, op. cit. p. 43.

especially when we seek to understand the etiology of brain disorders.*

It is not part of our object, however, to enter upon the numerous questions of innervation of the vessels, and space will not permit us to consider all the conditions under which contractions, dilatations, and reflex vaso-motor effects occur. The statement, that the mutual interaction of vaso-dilator and vaso-constrictor nerves, *plus* the factor of cerebral inhibition, are the main elements in the regulation vaso-motor tone in the brain, must suffice for the present. At the same time, bearing in mind that the local circulation is regulated mainly by the motor nerves, which issue from the ganglia of the sympathetic, and extend along the arteries throughout their entire course. This vascular tone is altered by pathological changes in the vessels themselves, as in atheroma, fatty, calcareous, and amyloid degenerations, senility, syphilis, alcoholism, etc., and it is of importance that we should take account of the action of the sympathetic system as a causal factor of pathological conditions, which are known to exist with various morbid mental states.

Althann,† more than twenty years ago, pointed out that fulness of cerebral vessels was no measure of the good or bad blood-supply of the nervous elements; but that oxygen was more readily brought to, and carbonic acid more readily removed from, these elements under such conditions. He regarded this as depending upon (*a*) the chemical constitution of the blood, and (*b*) the quantity of blood that passes through the capillaries in a given time. For an even and satisfactory

* Long Fox believes that in those forms of hysteria that depend upon definite uterine or ovarian lesion, the deep-seated sense of pelvic uneasiness, nearly similar in position and sometimes equalling in intensity the sacro-coccygeal pain attending piles, the paresis of intestine evinced by meteorismus, the increased flow of limpid urine, the vomiting, the hiccough, the frequent diarrhœa, the palpitation, the faintness, the sighing respiration, the globus, the difficulty in deglutition, the blushing, the dilated pupil, the tears, the tinnitus, the excitation of the emotional area, the occasional epilepsy, melancholia, mania, to which such patients are liable, are all examples of afferent irritation carried to the solar plexus, and thence, from ganglion to ganglion of the sympathetic chain, to the three cervical ganglia; thence to the eye, the cerebral vessels, and the medulla oblongata.

† Geigel, "Virchow's Archiv.," vol. cxix., p. 93.

flow of arterial blood through the capillaries Geigel employed the term "eudiæmorrhysis," whilst too little blood (true anæmia cerebri) and too much blood (true hyperæmia cerebri) were termed "adiæmorrhysis" and "hyperdiæmorrhysis" respectively. The same author stated that the velocity of the circulation of the blood in the capillaries of the brain is directly proportional to the arterial pressure, and inversely proportional to the resistance; and that the resistance depends directly upon the amount of intra-cranial pressure; therefore (as Fick has shown that the intra-cranial pressure is equal to the intra-arterial pressure, less the resistance which the tension of the arterial walls oppose to it), (1) if the contraction force of the arterial wall gets less, intra-cranial pressure will increase and the velocity will become less—*i.e.*, dilatation of an artery causes anæmia, and not hyperæmia; (2) contraction of the arteries of the brain will increase the velocity of the blood-flow through its capillaries. Again, suppose the heart acts more powerfully, raising intra-arterial pressure, while, at the same time, the arterial walls increase their contraction, intra-cranial pressure will be the same, or greater or less, according as the arterial contraction equals, or is less or greater than the rise of, intra-arterial pressure. Hence, with increased contraction of arterial walls, intra-cranial pressure decreases and capillaries widen. On the other hand, with diminished contraction of arterial walls intra-cranial pressure is raised, the capillaries are compressed, and the amount of blood circulating through them is diminished.*

Geigel believes that the symptoms of cerebral pressure are really due to the interference with the circulation which the pressure produces, and are not the direct result of the pressure on the cerebral substance; and in support of this he points out that, provided the cerebral circulation is not interfered with, the brain-substance will withstand a pressure of two atmospheres and more without harm. The symptoms of high intra-arterial pressure and of anæmia are very similar, because the supply of oxygen and the removal of carbonic acid are equally interfered with in the two conditions. Geigel regards the effects of embolism or rupture of a vessel as somewhat

* Haig, "Brain," p. 315.

similar; embolism or rupture of one intra-cranial artery producing temporary diminution of circulation in all the other intra-cranial vessels, and the apoplectic shock of embolism is thus due to diminution of blood-supply.

Lewy* believes that this argument holds good only under certain pathological conditions, but denies that it does so for physiological conditions. His views are: (1) that an intra-cranial artery cannot expand without taking space from other vessels, the space thus taken being so small, that in physiological conditions it affects the cerebro-spinal fluid, but not the capillary circulation at all; (2) that when an artery enlarges, the blood meets with less resistance in passing through it; and possibly the lessened resistance in the artery more than compensates for any slight increase of resistance in the capillaries due to the expansion of the artery; (3) that, conversely, contraction of an artery may increase the resistance more than the corresponding relaxation of capillaries diminishes it; (4) that, when the arteries all enlarge together, the lymph gets out of the way, and the capillaries are so numerous that they will bear a large amount of compression before they are so far closed as to hinder the circulation; and under these conditions narrowing an artery diminishes the blood-stream, and widening an artery increases it, so that arterial hyperæmia is possible. But beyond a certain point this does not hold, for if we imagine the arteries to enlarge so much that the veins are pressed flat, absolute stasis will result; if the arteries now begin to contract, passage of blood will begin again and increase, and thus a narrowing of the arteries produces hyperæmia; (5) if, however, part of the intra-cranial space is taken up by a tumour, or, again, if a large number of capillaries have been destroyed by injury or inflammation, then a smaller amount of arterial enlargement may seriously interfere with the capillary circulation.

Grashey† has shown that stasis in the veins may be due not only to the enlargement of the arteries, but also to a rise of intra-arterial pressure. When this pressure rises beyond a certain height the central veins begin to vibrate, and then the

* "Virchow's Archiv.," vol. cxxii. p. 146.

† "Experimentelle Beiträge zur Lehre von der Blut-Circulation in der Schädel und Ruckgratshöhle." J. F. Lehmann, München, 1892.

amount of blood streaming through is decidedly reduced. At this point it is possible that the symptoms of pathological brain-pressure begin.

Grashey believes that true hyperæmia cerebri is not proportional to arterial contraction, for, if the spastic contraction of arteries is very great, the blood-stream may be stopped altogether, and contraction or dilatation of arteries must influence intra-arterial pressure. Contraction of an artery diminishes, whilst dilatation increases, the pressure in it; therefore, dilatation of an intra-cranial artery increases the pressure on the veins and does harm. For the proper nutrition of the brain, a diminution of the amount of blood passing through the cerebral veins is unfavourable. When the veins and capillaries become overfilled with blood, the blood, as a result, is only able to move slowly. Grashey also believes that stasis in the veins adds to the intra-cranial pressure by causing an increase in the amount of cerebro-spinal fluid.

These effects of a dilatation of a cerebral artery are observed in the case of local dilatations only.

The points of importance in the observations of these authors are:—(1) That proper nutrition of the nervous tissues depends more upon freedom of circulation than upon the quantity of blood; and (2) that nutrition is carried on imperfectly if there is venous or capillary stasis through high intra-cranial pressure.

Burckhardt's experiments go to prove, that the activity of the hemispheres modify the influence of the vaso-motor centre upon peristaltic vascular movements; and that in sleep, when this activity is lowest, the vascular movements are most regular. Meynert refers the vaso-motor centres, which govern cortical influence, to the grey substance of the anterior division of the brain-trunk, in which are situated, also, the other motor tracts, subject to centrifugally transmitted cortical innervation. Further, if the cortex be excited in its capacity as a vaso-motor centre, the influence of the arterial systole upon the vaso-motor centre will be augmented, thus causing active anæmia of the brain, which, as a rule, remains entirely independent of the anæmia of the rest of the body. But since a functionally active cortex cannot impede the development of functional hyperæmia, we must assume that the physiological excitation of the cortex increases, in a centrifugal direction, the arterial diastole which forms part of a peristaltic movement. Meynert also believes, that deficient or diminished cortical activity, as seen in various psychical conditions, is attended by an increase of excitation of the vaso-motor nerves connected with this part of the cortex, and thereby affects the blood-supply as well as the chemical changes in the brain, and that increase in functional activity of the cortex is attended by diminution of cortical vaso-motor influences. Whence, he says, it follows that a cortical process of association by inhibiting vascular innervation will result in immediate functional hyperæmia. He seeks to explain, that the cortex in a state of functional activity imparts an impulse inwards (centrifugally) to the vaso-motor centre, and, that in some way or another, this impulse is transmitted in a centripetal direction from the subcortical centre reacting upon the vascular system. The view, that hyperæmia of the superior surface of the brain occurs in direct relation to psychical activity, is supported by the observations of Mosso, Batty Tuke* and Gibson, who have each made observations upon this point. Batty Tuke, however, regards it still as an open question, as to whether this functional hyperæmia is produced by reflex inhibition of the vaso-constrictor centre by direct action of vaso-dilator fibres, or by a combination of the action of the two systems.

From these considerations, as to the complex conditions of nutritive supply, we are now in a position to appreciate how essential to mental life is the proper working of the mechanism whereby nutrition of the nervous elements is effected. It need, therefore, scarcely be urged that, if our object be to understand how morbid psychical manifestations may arise through defect of, or interference with, the effective working of the cerebral mechanism, the study of the varying conditions of nutrition of the brain is of primary importance to us, and the importance of it to us can scarcely be over estimated.

* "On the Insanity of Over-exertion of the Brain," p. 18.

CHAPTER III.

Scheme of the Central Nervous System.

Sensory Paths—Cerebral Localisation for Touch—Course of Sensory Fibres—Special Senses: Sight, Hearing, Smell, Taste—Motor Nerves: Cerebral Localisation—Projection Systems: Association Fibres, Fimbriæ Propriæ—Value of our Knowledge of Cerebral Localisation: Phrenology, Experimental Research, Comparative Anatomy, Morbid Anatomy—Sensori-Motor Areas and their Relations to Mental Faculties: Views of Hitzig, Ferrier, Munk, Waller, etc.—Conclusions.

SCHEME OF THE CENTRAL NERVOUS SYSTEM.

Hitherto we have considered certain nervous elements, as far as possible, according to their individual anatomical and physiological peculiarities. It is now our task to obtain a general view of the chief arrangements of these individual parts in the complicated structure of the brain. A description of the manner in which the elements are combined is obviously indispensable to us. For convenience we shall consider the general scheme of the central nervous system in its *triple form*, both anatomically and physiologically.

We shall, therefore, so far as may be essential to our purpose, attempt to comprehend the complicated system of afferent, associative, and efferent nerve-tracts as a systematic whole, and it is obvious that the consideration of every psychical process deemed to have a demonstrable physiological correlative involves, at least, the study of some part or other of this system.

It is known to every student that the grey matter of the cerebrum is placed external to, and spread as a thin coating over, the white matter of the centrum ovale. The folding of this grey matter into gyri or convolutions, and their anatomical lines of demarcation, by means of fissures or sulci, are facts also equally well known. Nor do we need to enter upon a description of the arrangement of the masses of grey matter at the base of the brain, which form the corpus striatum (the caudate and lenticular nuclei), the optic thalamus, the corpora quadrigemina, and the red nucleus and locus niger within the tegmentum of the crura cerebri. The formation of the central grey tube as a continuation of the grey matter of the cord through the medulla, pons, round the iter, and ending at the tuber cinereum, is a study of great complexity; and the variety of ways in which these various parts are connected with each other, by transverse fibres stretching between the two sides of the brain, or by longitudinal fibres extending from the hinder and lower to the fore parts of the brain, is worthy of careful consideration.

The cortex cerebri, as we have already seen, contains in its structures the elements which are regarded as being most closely associated with psychical action. To it, all the fibres coming from sensory organs, proceed, and they convey the effects of peripheral or external stimulation to the region, or regions, where psychical perception of external agents is supposed to take place.

Our knowledge of these sensory paths is, as yet, unsatisfactory and wanting in precision. Sensory impulses enter the spinal cord by the posterior nerve-roots, and may pass, if to the cerebellum, through the cerebellar tract and posterior column to the restiform body, and thence to the cerebellum; or, if to the cerebrum (after decussating in their course in the cord), through the posterior half of the pons, into the tegmentum of the crus under the corpora quadrigemina, to enter part of the posterior third of the posterior segment of the internal capsule. The subsequent course of these fibres, however, is somewhat doubtful; some fibres enter the optic thalamus (Meynert); others pass into the white matter of the cerebrum. According to Meynert, the sensory columns of the cord turn suddenly back from the posterior third of the internal capsule, and are distributed to the occipital and temporo-sphenoidal lobes. From the occurrence of impairment of tactile sensibility, associated with disease of the motor regions of the cortex, Gowers asserts that some of these fibres go to the parietal and central regions. Whether some of the fibres pass into the optic thalamus, or whether they have no connection with it, but pass, as stated by Bevan Lewis, uninterruptedly between the lenticular nucleus, thalamus, and caudate nucleus, to their cortical termini, is not yet clearly decided.

Ferrier found that, when parts of the gyrus hippocampi were removed, loss of sensation occurred on the other side of the body. Horsley and Schäfer found similar results from destruction of parts of the gyrus fornicatus. Horsley has also found that when parts of these gyri were removed in man, there was slight loss of sensation; the patient being unable to feel very slight touches of the limb, and the point localised as touched was usually a segment higher up than the actual point touched.

The observations of Flechsig, Monakow, and Déjerine seem to demonstrate that the course of the sensory paths (kinæsthetic) is up the posterior columns of the cord, through the posterior column nuclei, the internal arciform fibres; thence, after decussation, by the inter-olivary tract and fillet of the opposite side to the posterior part of the internal capsule, and eventually to terminate in the central convolutions. Mott* has demonstrated that the so-called motor cortex is concerned with the reception of afferent sensory impulses. This view is supported by the experiments of Hitzig, Munk, Luciani and Seppili, Tripier and Moelli. Horsley found undoubted sensory defects following the removal of large portions of the Rolandic area in man. Allen Starr has endeavoured to demonstrate that the tactile sense-centres are situated in the Rolandic area, especially behind the fissure of Rolando. Wundt, Bastian, and James agree that the central convolutions possess sensory functions. Mott considers that this view is fully supported by the facts of anatomy, embryology, experimental physiology, pathology, and clinical observation. To account for the fact that the motor paralysis is greater and more permanent than the loss of sensory functions, Mott compares the expansion of the centrifugal and centripetal fibres of the internal capsule to two funnels; the fibres as they lie in the capsule forming the tubes, and expanding

* "British Medical Journal," Sept. 1893, p. 685.

above like cones, the bases of each of which are nearly coincident although the tubes are not. He says there is one important difference, however; the base of the efferent cone is made up of axis-cylinder processes just after leaving the cells from which they grow; that is (comparing a nerve-fibre to a tree), the base of the efferent cone consists of the trunks, from which all the branches and collaterals spring. The base of the sensory cone in the cortex consists only of the terminal twigs of the afferent nerve trunks. As the afferent fibres to the cortex form an arborisation before terminating in the grey matter, it is conceivable that a small portion of grey matter of the area connected with tactile perceptions will suffice to restore function, but removal of the base of the efferent cone prevents any voluntary motor impulse starting.

So far, however, it has been found impossible to localise accurately the areas which represent the different parts of the body. On the grounds that definite localisation of the centres of sight, hearing, smell, and, probably, taste, as well as the respective motor centres, is possible, Ferrier assumes there must be a definite region for the various forms of sensibility included generally under the sense of touch, contact, pressure, temperature, etc. He says,* that up to the point of radiation into the cerebral cortex, the sensory paths have been proved to be entirely differentiated from the motor; and that the two should become jumbled together indiscriminately in the cortical centres is a hypothesis which, *primâ facie*, is extremely unlikely.

In the spinal cord the sensory and motor nerves are distinct from one another. In the pons and crura cerebri they still remain apart. The observations of Veyssière, Charcot, Reymond, Rendu and others, go to prove that in the internal capsule the sensory tracts are quite distinct from the motor, and may be injured or diseased separately, causing hemianæsthesia on the opposite side of the body as the result.† When the region of the sensory paths in the internal capsule is divided, volitional movements can be effected, but there is no corresponding consciousness by means of the muscular sense. Ferrier asserts, that the same condition which abolishes cutaneous sensibility also entirely annihilates

* "Functions of the Brain," 2nd edit., p. 323.

† Ferrier, *ibid.*, p. 323.

the so-called muscular sense; and that there is no necessary relation between the power of effecting movement and the sense of movement effected—*i.e.*, the paths of muscular sense are quite distinct from the paths of volitional impulse.

Flechsig maintains, that the tracts forming the outer third of the foot of the crus radiate from the internal capsule outwards and downwards towards the hippocampal region. Ferrier found, that destructive lesions of the hippocampal region caused profound impairment or total abolition of cutaneous, muco-cutaneous, and muscular sensibility; and that the degree of duration of the anæsthesia varied with the completeness of destruction of the region in question. Since, however, recovery sometimes takes place after the removal of the hippocampal region only, Horsley and Schäfer made additional experiments, and found that destruction of the gyrus fornicatus alone could produce analgesia and anæsthesia of the opposite side of the body. The falciform lobe is now regarded as the cortical centre of those fibres of the internal capsule, destruction of which is the cause of hemianæsthesia of organic origin.*

The sense of movement (kinæsthetic sense) will be considered with more convenience when we come to study the motor centres; so we leave this subject for the present and take up briefly that of the special senses.

Sight.—The most important of the special senses is that of sight. Gratiolet believed the optic tract to be directly connected with every part of the cerebral hemisphere, from the frontal to the occipital lobe in man. Hamilton has demonstrated that its connections are very numerous; but the observations of Gratiolet have not been confirmed. Certain fibres are connected with the basal ganglia, whilst others are connected with the cortex. The former probably arise from the

* Ferrier says:—"The symptoms observed in the animals operated on prove that the centres of mere touch proper are precisely the same as those of painful sensation—whether from pressure, heat, or otherwise—the latter being merely an intense degree of the former." "All the facts receive the most satisfactory explanation, if we regard the falciform lobe as a whole, and in each and every part the centre of tactile sensation for the whole of the opposite side of the body; though probably the various motor centres are each anatomically related by associating fibres with corresponding regions of the falciform lobe. The association would form the basis of a musculo-sensory localisation."—"Functions of the Brain," p. 344.

corpora geniculata, pulvinar, and anterior quadrigemina, and from the substance of the thalamus; whilst the latter (cortical fibres) join the former to form the optic tract.

In the frontal region, the connection with the cortex is effected through "Meynert's commissure" (Hamilton).*

To attempt to elaborate or explain the relation of the fields of vision of the retina, tracts, and the cerebral optic centre, is obviously outside our object; nor can we undertake to explain some of the eye-symptoms which occasionally occur in cerebral disease. Gowers states that affections, (*a*) of the optic nerve (between the eyeball and the chiasma)—*i.e.*, in the orbit, optic foramen, or within the skull—affect one eye only; (*b*) of the middle of the chiasma, cause temporal hemiopia; (*c*) of the optic tract (between the chiasma and the occipital cortex), cause hemiopia, which is always symmetrical.

The centre for sight has been localised in the angular gyrus, around the posterior end of the parallel sulcus, and in the occipital lobe. Ferrier, Horsley, and Schäfer have found that complete permanent hemiopia for the opposite field of vision is only produced when both these parts are removed. If one occipital lobe be ablated, there is hemiopia for the opposite field of vision, but this is of a temporary nature. Ferrier has also found, that when the angular gyrus of one side alone is removed, complete blindness of the opposite eye is caused, from which, however, the animal soon recovers. Gowers regards

* According to Hamilton, other cortical connections join the tract as it winds round the cerebral peduncle. These other connections comprise—(1) a large mass of fibres coming from the motor areas of the opposite cerebral hemispheres, crossing in the corpus callosum, entering the outer capsule, and joining the tract directly; (2) fibres uniting it to the temporo-sphenoidal lobe of the same side, especially the first and second temporo-sphenoidal convolutions; (3) fibres to the gyrus hippocampi of the same side; (4) a large leash of fibres forming the "optic radiation" of Gratiolet, which connect it directly with the tip of the occipital lobe. There are probably also indirect connections with the occipital region through some of the basal ganglia. These connections with the frontal and sphenoidal lobes are not admitted by some investigators, but all are agreed as to its connection with the occipital by means of the "optic radiation." The optic radiation gives fibres to the optic tract, to the corpus geniculatum internum and externum, to the pulvinar and thalamus, to the posterior third of the posterior limb of the inner capsule ("sensitive band" of Meynert) and fibres which run between the island of Reil and the tip of the occipital lobe.

the angular gyrus as containing a higher visual centre, in which the half fields are combined, and the whole opposite field is represented. Ferrier believes, that each hemisphere is in relation with the corresponding half of both retinæ, and that the semi-decussation of the optic tracts is maintained in the cortical centres ; and in addition to the representation of the correlated halves of both retinæ in the corresponding occipito-angular region, the angular gyrus is the region of clear or central vision of the opposite eye, and, perhaps, to some extent, also of the eye on the same side. Ferrier says—“ Each occipital lobe is in relation with the half of each retina on its own side, while each angular gyrus is in relation with the centre of the opposite eye, partly by fibres which are supposed to cross in the chiasma, and partly by fibres which reach it after decussation in the lower visual centres—possibly the corpora quadrigemina. At the same time, also, a partial intermingling in the chiasma of the fibres from the centre of each eye brings each angular gyrus, to some extent, also in relation with the eye on the same side.”*

There are some small fibres at the posterior part of the chiasma which run along the mesial side of the optic tracts to join the internal geniculate bodies of the two sides. These fibres form the *inferior commissure of Gudden ;* but they are not supposed to have any visual function. Darkschewitsch states that this commissure unites each mesial geniculate body with the lenticular nucleus of the opposite side.†

The intercentral connections of the nervous visual apparatus are probably as follows : A set of fibres passes from the higher visual centre in the occipital lobe through the corona radiata and caudal end of the internal capsule, to the grey matter of the lower optic centres, where they end in arborisations. Another set arises in the lower optic centres, and terminates by arborisation in the occipital cortex. There appears to be some connection between the grey matter of the bulb and cord and the lower optic centres. There is some direct connection (through the tract of the upper fillet) between the cerebellum and the fibres of the optic tract.

* “ Functions of the Brain,” p. 292.

† “ Quain’s Anatomy,” vol. iii. pt. I. p. 118.

Munk * maintains that the identical points of both retinæ do not correspond to the same points of the cerebral cortex, but that the external half of each retina is associated with the outer half of the visual area of the same side, and the inner half

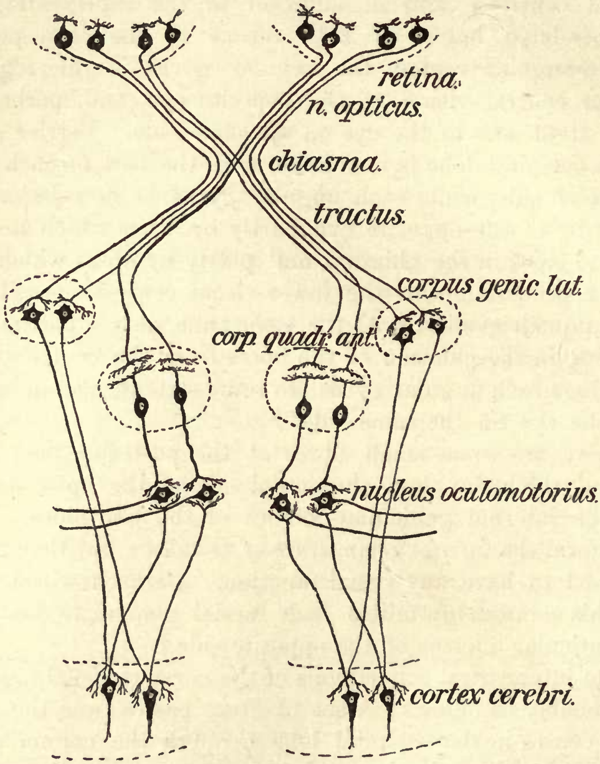

FIG. 10.

DIAGRAM OF THE PROBABLE COURSE AND RELATIONS OF SOME OF THE OPTIC FIBRES.

(*After Schäfer and Thane.*)

of each retina with the inner half of the corresponding visual area of the opposite side. The relation of the visual area of the cerebral cortex to eye-movements is not yet definitely settled ; nor do we know the exact connection between the optic centres

* "The Visual Area of the Cerebral Cortex."—"Brain," 1890, p. 45.

and the nuclei of the nerve to the muscles of the globe of the eye. It is thought possible that this connection may be partly effected through the posterior commissure and posterior longitudinal bundle, and that it is probably both crossed and uncrossed. Munk found that stimulation of the cortex (in dogs) somewhat beyond the anterior border of the visual area, or beyond the lateral border of the visual area in the auditory centre caused cessation of eye-movements. When these movements do occur they are supposed to be the results of locally-restricted stimulations of portions of the visual area.

When there is total extirpation of both visual areas, perfect blindness results, but eye-movements may remain intact, except those which are entirely dependent upon vision. Munk regards the visual area as having nothing to do with those eye-movements which are independent of sight; neither do these movements result from excitation of the visual areas, nor does the path of conduction from the place of their excitation to the periphery lead through the visual centres; consequently the eye-movements which the electrical irritation of the visual area induces, only correspond to particular eye-movements which are the results of visual perception. He further believes that, outside the visual area, and in his "tactile sphere," there are two spots on the cortex, the electrical stimulation of which causes eye-movements; and as one or the other spot is excited, so will the eye-muscles which are set in motion give rise to particular movements, just as arm or leg muscles will be brought into action by stimulation of neighbouring spots on the motor areas.*

* "Therefore," he says, "if an animal makes a movement in consequence of having seen anything, it must be concluded that the excitation conducted through the optic nerve-fibres to the visual area is transferred by associated fibres which connect these same areas with the tactile areas, at one time by this set of associated fibres, at another time by that—according to the kind of movement produced; and so through certain association fibres the excitation reaches the spots C or D if arm or leg-movements occur, through other associated fibres the spots F or H if eye-movements take place. In analogous fashion the eye-movements are obtained in our case by excitation of the visual area with induction currents, since the excitation produced by the electrical current spreads to the centres F and H by associated fibres, which run from the visual areas to those centres, whether excitation is originated by the current in the central elements of the visual area, or in the fibres themselves where they terminate in the visual area."

Munk attaches no significance to the commissural fibres which pass out of the visual areas into the corpus callosum. He concludes that eye-movements are caused by the electrical stimulation extending to the radiating fibres of the corona radiata which go to the subcortical parts of the brain, and that the excitation starts in the central elements of the visual area—*i.e.*, in the radiating fibres where they proceed from the visual areas. These movements correspond more especially to those eye-movements which produce "wandering vision" and fixation of the eyes upon an object previously indistinctly seen. Further, the portions of both retinæ of the corresponding side, which are on the same side of the maculæ lutæ, belong to each visual area; while the upper, middle, and lower quadrants of those portions of the retina, belong to the anterior, middle, and posterior zones of the visual area respectively. Munk also upholds the view, that the visual nerve-fibres, after their entry into the visual area, are connected directly and immediately with the central elements which serve for the perception of light.*

Sherrington,† however, has found that, in the monkey, after a deep frontal section across the hemisphere and into the

* The projection of the retinæ upon the visual areas, according to Munk, presents itself now in its full significance as the substratum for the localisation of the visual perceptions, since the involuntary eye-movements, which are brought about through the radiating fibres, supply the necessary complement. Successive and opposite positions of the objects in Helmholtz's visual fields are yielded by projections, the judgment being assisted by the sensations which bring about these involuntary eye-movements, upwards, downwards, right or left; thus projection and eye-movements together, permit such rapid and certain cognisance of the visual field, as we observe in animals, and which would be quite impossible if it were necessary to deliberate regarding every detail in the visual field. The discovery of the new radial fibres of the visual area will prevent the anatomical investigator from being able, without further consideration, to refer all descending degenerations which result from removal of that area to the tracts which conduct visual impressions; but there is, on the other hand, now opened up to him the prospect of being able to distinguish the two kinds of central elements, and of being able to demonstrate their morphological differences—a prospect which is attractive by reason of the proved connection of the radiating fibres with the light-perceiving central elements, and of the associated fibres with the representative elements (Vorstellungselementen). "Brain," 1890, p. 65.

† "Royal Society Proceedings," vol. xxxv. p. 407. "Journal of Physiology," vol. xvii., No. 1, 1894.

lateral ventricle (partly entering the internal capsule) so as to sever occipital from frontal cortex, he could still evoke movements by appropriate excitation of all that portion of the cortex which, on excitation, gives conjugate lateral deviation of the eyes—*i.e.*, from the area discovered by Ferrier in the frontal region, and from that discovered by Schäfer in the occipital region. The reaction could also be obtained by excitation of (1) the *corona radiata* underlying the frontal cortex after complete ablation of the cortex itself; (2) the *corona radiata* running downwards and forwards from the occipital cortex after free removal of the latter; (3) the internal capsule itself at two distinct places, one in front of, the other behind, the genu; (4) the cross-section of the corpus callosum about 3—5 millimetres behind the genu; also at the splenium. Sherrington concludes that the inhibition, which can be elicited by experimental excitation of the grey cortex and of the underlying white matter, is fully and habitually exercised in volitional eye-movements. He also concludes that the action may take place, and probably does so usually, in centres which are subcortical; and that the grey matter of the cortex is not essential to the phenomenon.

Hearing.—The auditory nerve is regarded not only as the nerve of hearing, but also as participating in another function—viz., that of helping to maintain the equilibrium of the body through its connection with the semicircular canals. The nerve arises by two roots: a larger anterior root, from which proceeds the vestibular nerve; and a smaller posterior root, from which the cochlear nerve comes. Each root springs from a median and a lateral nucleus. The fibres from the cerebellum are regarded as being concerned with equilibration. The chief mass of the posterior ganglion fibres of the cochlear nerve cross and pass to the corpora quadrigemina, the internal geniculate body, and to the temporo-sphenoidal lobe. The striæ acusticæ form a second decussating projection system, and according to Flechsig, the origins of both acoustic nerves are connected by commissures in the brain. The physiological significance of the exchange of fibres between the auditory and the portio intermedia of the facial nerve is not known.

The centre for hearing has been localised by Ferrier in the first temporo-sphenoidal convolution. According to Munk, destruction of the entire region causes deafness of the opposite ear, while destruction of the middle shaded part alone causes "*psychical deafness*" (Seelentaubheit). Bilateral lesions of the first and second temporo-sphenoidal convolutions in man cause complete deafness. Disease of these convolutions is attended with *word-deafness.*

The *auditory paths* are from the auditory nuclei in the medulla oblongata through the pons, where they perhaps cross into the tegmentum, thence into the sensory crossway, and onwards to the auditory centre.* Gowers records two cases of tumour of the first temporo-sphenoidal convolution, in which there were fits beginning with an auditory aura referred to the opposite ear.†

Equally important with these effects of disease are the sensory impressions, or "*auræ,*" as seen in epilepsy; and just as a discharging lesion of the occipital lobes may cause flashes of light or coloured visual auræ, so sounds or noises may arise through affection of the first temporo-sphenoidal convolution, and usher in an attack of epilepsy. Mills‡ has recorded a case of word-deafness following an apoplectic seizure, and more complete deafness and partial left-sided paralysis following a second apoplexy. In this case there were lesions of the first and second temporal convolutions of both hemispheres.

The auditory centres are best developed in the left hemispheres, but in order to produce complete brain-deafness destruction of both centres is essential. When the posterior thirds of the first and second temporal convolutions of the left hemisphere are destroyed, an almost complete word-deafness is produced. When a lesion is limited to the centre for word-hearing, and causes word-deafness, it will also cause paraphasia and paralexia. In time, such a lesion will lead to secondary atrophy of the speech and oro-lingual centres, and also to affections of the association tracts between the sensory and motor-hearing speech centres. The field for all auditory memories

* Landois and Stirling, p. 704.

† "Tuke's Dictionary," p. 156.

‡ "Brain," 1891, p. 468.

seems to include the posterior two thirds of the first and second temporal convolutions. When there is word-deafness there is not necessarily, therefore, inability to recall words through other channels; as, for instance, through their visual signs, in which case the meaning of the word may be understood, although the name cannot be properly verified in consciousness.*

Smell.—The olfactory centre, as inferred from anatomical considerations and direct experimentation, is probably localised in the anterior extremity of the temporo-sphenoidal lobe. Ferrier has found, that destruction of this part produced loss of smell on the same side in monkeys. Hughlings-Jackson, and Beevor† have published a case in which there was a growth in the right hippocampal lobule, associated with epileptic fits, which were preceded by the sensation of an unpleasant smell.‡ The olfactory bulb and tract, in respect of structure and connections, are regarded rather as constituent parts of the cerebrum than as a true nerve. The tract is a triangular band of white matter, inclosing a central grey neuroglia substance. It lies in the olfactory sulcus parallel to the longitudinal median fissure. Anteriorly, it is continuous with the olfactory bulb, which rests on the cribriform plate of the ethmoid bone, and receives the fibres of the olfactory nerves, which come from the cells of the olfactory mucous membrane. Posteriorly, it bifurcates into two roots—mesial and lateral—which diverge as they pass backwards, and inclose (1) a space (the *trigonum olfactorium*), which is known as the middle or grey root of the tract; and (2) a portion of grey matter lying between the mesial root and the peduncle of the corpus callosum, and continuous with the commencement of the callosal gyrus.§ The mesial root, in passing over the *trigonum olfactorium*, subdivides it into two parts. Fibres pass from this root to the area of Broca, and others pass directly from the posterior end of the tract into the trigonum, to join the anterior commissure, and thence to the posterior part of the temporal lobe; or, according to Meynert, they may cross in this commissure to the temporal lobe and hippocampal region of the opposite side. Fibres from the posterior end of the

* Mills, "Brain," 1891, p. 468.

† "Brain," part XLVII.

‡ "Tuke's Dictionary," p. 156.

§ Quain, vol. iii. pt. I. p. 159.

olfactory tract also pass directly into the white matter of the frontal lobe.*

The outer root consists of a band of medullary fibres, which passes along the outer part of the anterior perforated space, to disappear about the posterior border of the Sylvian fissure. It has been traced by some to the island of Reil, the optic thalamus, and to a nucleus in the substance of the temporo-sphenoidal lobe, in front of the anterior extremity of the hippocampus.

Taste.—The sense of taste is supposed to have its centre in close relation to that of smell, and, according to Ferrier, it is probably situated somewhere about the lower extremities of the temporo-sphenoidal lobes. The gustatory path crosses in the posterior part of the posterior segment of the internal capsule. Gowers thinks that taste-impressions reach the brain solely by the roots of the fifth nerve, and not through the glosso-pharyngeal nerve. He admits, however, that the nerves of taste to the back part of the tongue may be distributed with the glosso-pharyngeal, reaching them through the otic ganglion by the small superficial petrosal and tympanic plexus. The centres which we have considered occupy parts of the non-excitable cortex. This non-excitable area has been divided into (1) the parts behind and below the excitable cortex, as well as the convolutions on the median surface of the brain, except the marginal gyrus; and (2) the frontal region anterior to the excitable area. We shall return, however, to the consideration of these later; and for convenience' sake we shall now look at the construction of the apparatus by means of the working of which mechanical movements are effected.

Motor Nerves.—The course of the fibres which convey impulses for motion is as follows:—The pyramidal tracts pass from the motor areas of the cortex through the white matter of the cerebrum to the internal capsule, where the fibres for the face and tongue occupy the knee of the capsule, those for the arm the anterior third of the posterior segment or limb, whilst those for the leg occupy the middle third. They then pass beneath the optic thalamus to the crusta of the cerebral peduncle, which they enter and occupy its middle third; the fibres for the face lying next to the middle line, then the fibres

* Quain, op. cit., p. 160.

for the arm, and external to these the fibres for the leg. Their subsequent course is to the pons on the same side, where the fibres for the face and tongue cross to the nuclei of the facial and hypo-glossal nerves of the opposite side. The fibres for the arm and leg go to the medulla oblongata, where they form the anterior pyramids. Subsequently, the greater number cross at the decussation of the pyramids to form the crossed pyramidal tracts, or lateral columns of the opposite side; whilst a lesser number continue on the same side as the direct pyramidal tracts.* The question as to whether there is ultimate crossing of the latter set of fibres need not detain us here. According to Mellus† and Sherrington,‡ some fibres pass to the crossed pyramidal tract of same side. The pyramidal fibres are connected with multipolar nerve-cells of the grey matter of the spinal cord at successively lower levels, and it is from these multipolar nerve-cells that the anterior roots of the spinal nerves arise. A somewhat similar course is known to exist for some of the motor cranial nerves. After leaving the internal capsule and the crusta they pass across the middle line to their respective nuclei, from which fibres proceed to the muscles supplied by these nuclei.

The excitable part of the cortex is, in the monkey, around the fissure of Rolando, and includes the ascending frontal and parietal convolutions with the parietal lobule, and the posterior parts of the three frontal convolutions, as well as the corresponding part of the marginal convolution on the median surface of the hemisphere. The exact localisation of the excitable areas of the cortex is of importance not only in determining the seat of discharging lesions, causing local epileptiform fits, but also in determining the possible relations which exist between various psychic functions and their expression in motion. In brief, stimulation of certain parts of the excitable cortex is supposed to give rise to movements in their corresponding muscular areas. These relations may be tabulated as follows:—

* Muratoff, "Neurologisches Centralblatt," March, 1892; also "Archiv. für Anatomie und Physiologie," 1893, Heft iii.

† "Proc. Roy. Soc.," 1894.

‡ "Lancet," 1894.

In Monkey.

Area stimulated.	*Results of stimulation.*
Part of marginal gyrus opposite to the ascending frontal convolution.	Movements in limbs and trunk-muscles of the opposide side of the body (Horsley and Schäfer).
Next to the preceding area, on the outer surface, the upper ends of the ascending frontal and parietal convolutions as far out and down as the horizontal level of the superior frontal sulcus, and as far forwards as the vertical limit of the præ-central sulcus.	Movements in lower limb opposite side (Ferrier).
Below this latter area, the ascending frontal and parietal convolutions down to the genu or bend in the fissure of Rolando; bounded below by a line drawn from the upper end of the præ-central sulcus backwards through the genu of the Rolandic fissure to the anterior end of the intra-parietal sulcus, and in front by a line drawn from the præ-central sulcus upwards to the middle line.	Movements in upper limb.
Below this latter area, a narrow strip of cortex.	Closure of opposite eye-lids, and if the current is stronger, closure of eye-lids on same side (Horsley and Beevor).
Below this area, and between the Rolandic fissure and the præ-central sulcus.	Elevation of the opposite angle of the mouth.
Round the lower end of the Rolandic fissure.	Retraction of the angle of the opposite side of the mouth.
Between the inferior end of the Rolandic fissure and the fissure of Sylvius.	Bilateral movements of opening the mouth.
In front of the latter area, and bounded below by the fissure of Sylvius, three small areas from behind forwards.	Rhythmical movements of mastication, swallowing, and adduction of vocal cords.
Posterior part of third frontal convolution (left side).	Aphasia.
Posterior part of three frontal convolutions in front of vertical limb of præ-central sulcus, and a line drawn between this and the middle line, (*a*) in the angle formed by the two limbs of this sulcus; (*b*) between the horizontal limb of this sulcus and the middle line; (*c*) below the latter area.	(*a*) Synchronous movements of turning head and eyes to opposite side; (*b*) head tends to move without or before the eyes; (*c*) synchronous movements of the eyes occur before or without the head.

Reference to Fig. 11 will show, that as we pass from the marginal gyrus along the fissure of Rolando, we meet with areas which represent a gradual increase in complexity of function. No sharp line of demarcation is possible, however, between these areas of representation. Horsley and Beevor have given the name of "border centres" to those places, stimulation of which causes combinations of movements. The same authors have found that the different segments of the limb have areas of representation; those for the lower limb being (in the monkey) in the following order from before backwards—viz., hip, knee, ankle, and hallux; whilst in the upper limb area they occur in the order from above downwards

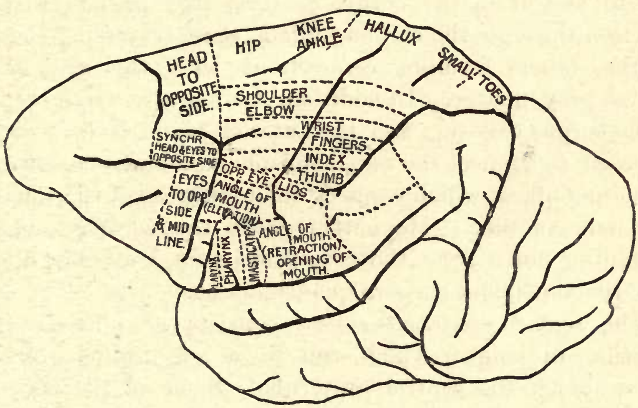

Fig. 11.

Diagram of Motor Areas.

(After Horsley and Beevor.)

—viz., shoulder, elbow, wrist, fingers, index finger, and thumb, the three first being most represented in front of the fissure of Rolando, while the three last are behind it (Beevor). We have, therefore, in the cortex cerebri some fairly definite areas which are apparently directly concerned with the reception of incoming stimuli, and others which are apparently concerned with outgoing impulses or motor stimuli. In addition to these areas, however, there are others, which, so far as we know at present, are non-excitable. Ferrier, Horsley, and Schäfer have removed that part of the cortex of the frontal lobe situated anterior to the areas which we have seen to be excitable, with the result, that there were no observable sensory or motor symptoms; moreover, there was little or no change observable in the mental condition. Ferrier noted a marked mental change when the cortex was stripped from this area on both sides of the brain, but Horsley and Schäfer found no mental change whatsoever. We shall have occasion later to return to the question of the functions of this part of the brain, and of the possible relations it may hold to the rest of the cortex, so we now pass to the consideration of the arrangement of fibres, in the so-called "projection systems."

Projection Systems.—Meynert has described three such systems. The *first projection system* consists of fibres which lead to and from the cortex cerebri; they pass in a *radiate* direction through the corona radiata, some traversing the basal ganglia, others forming connections with the cells of the central grey matter. In addition, there are *commissural* fibres of the corpus callosum and the anterior commissure, which are supposed to connect the two hemispheres; and connecting or *associating* fibres, which connect different areas of the same side with one another. Meynert regards the corona radiata as containing fibres from the corpus striatum, lenticular nucleus, optic thalamus, and corpora quadrigemina.

The *second projection system* consists of fibres of great variation in length, which run in a longitudinal direction downwards to the central grey tube. Some of the fibres end in this central grey matter, while others pass to the level of the lowest spinal nerves. The fibres which descend from the caudate and lenticular nuclei pass through the crusta of the cerebral peduncle, and enter the medulla or pons (Flechsig). Those from the thalamus and corpora quadrigemina pass through the tegmentum to join others from the crusta in the spinal cord. Wernicke believes that the caudate and lenticular nuclei are independent, and that the radiate fibres from the *corona radiata* do not enter them. Fibres, however, may proceed from them to the crusta, to join those fibres coming from the thalamus and corpora quadrigemina. Meynert regards the latter set of fibres as being reflex channels, and he looks upon these regions of the brain as centres for certain extensive co-ordinated reflexes.

The *third projection system* consists of the sensory, and motor, peripheral nerves. In the medullary centre we have, therefore, three systems of fibres—viz., Projection-fibre, Commissural-fibre, and Association-fibre systems.

The projection fibres are regarded as being direct prolongations of the axis-cylinder processes of cells of the cortex. The commissural fibres, which connect the hemispheres, include, as before mentioned, the transverse fibres of the corpus callosum, and the fibres of the anterior commissure. The fibres of the corpus callosum come from the cells of the cortex direct, or they are collaterals derived from the projection system. Sherrington has demonstrated that not only does the anterior portion of the corpus callosum contain fibres from the frontal lobes, the middle from the middle lobes, and the posterior from the occipital lobes, but that there is also a tendency to scattering of fibres, so that not only similar but also dissimilar parts of the two hemispheres are connected through this commissure.*

Hamilton states that some projection fibres also cross the callosum, and then turn downwards in the internal capsule. The anterior commissure is made up of fibres, which chiefly connect the temporal lobes of the two hemispheres. These fibres spread out into a fan-like arrangement in the temporal lobes. There are also some fibres which are thought to connect the olfactory tract of one side with the opposite hippocampal gyrus.†

The *association fibres* vary considerably in length. The *fibriæ propriæ* (Meynert) are short fibres which pass below the grey matter at the bottom of the fissures, and serve to connect adjacent convolutions; while the long fibres run free or are grouped into bundles in one of the following directions:—(1) a *superior* bundle runs below the grey matter of the cortex, serving to connect the frontal and occipital lobes, and the frontal and external part of the temporal lobe: (2) an *inferior* bundle runs a course near the outer wall of the posterior and inferior cornua of the lateral ventricle, and serves to connect the temporal and occipital lobes: (3) an *anterior* bundle

* "Journal of Physiology," 1890.

† "Archiv. für Psychatrie," 1878, vol. ix.

passes across the bottom of the fissure of Sylvius, and connects the frontal, especially the third, with the temporal lobe and the anterior part of the limbic lobe: (4) the *cingulum* forms the chief bundle of the gyrus fornicatus, its fibres pass from the anterior perforated space in front, above the transverse fibres of the corpus callosum, to curve round the splenium of the callosum behind, and to reach as far as the anterior extremity of the gyrus hippocampi. Some of the fibres diverge into the white matter of the hemispheres, and, according to Beevor,* they probably connect the hippocampal and callosal gyri with the cortex of the outer surface of the

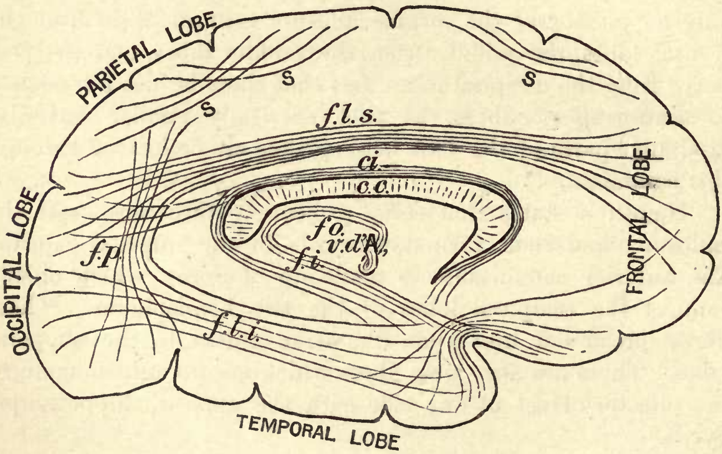

Fig. 12.

s, Short association fibres connecting adjacent gyri; *f.l.s.*, fasciculus longitudinalis superior; *ci.*, cingulum; *c.c.*, corpus callosum; *f.p.*, fasciculus perpendicularis; *f.l.i.*, fasciculus longitudinalis inferior; *fo.*, fornix; *f.i.*, fimbria; *v.d'A.*, bundle of Vicq d'Azyr.

(*After Meynert.*)

hemispheres: (5) a *perpendicular* bundle runs in front of the occipital lobe, and connects the inferior parietal lobule with the fusiform lobule:† (6) the fibres of the fimbria of the fornix connect the hippocampal region of the limbic lobe with the corpus albicans; and, through the bundle of Vicq d'Azyr, with the thalamus opticus.

* "Phil. Trans.," 1891.

† Wernicke, "Lehrbuch der Gehirnkrankheiten," 1881, vol. i.

Value of our knowledge of Cerebral Localisation.—Hitherto, the attempt to proceed beyond the objective evidences of the localisation of the motor and sensory functions, to the localisation of the parts of the brain subserving the subjective side of mental phenomena has been attended with very great difficulty, and these subjective conditions still remain upon a most unsatisfactory basis—*e.g.*, in various morbid mental conditions, where the state of consciousness is more or less altered, it is difficult to explain or localise the seat of the lesion when there is no evidence of paralysis of the motor or sensory functions, and *vice versâ*. The nearest approach to the connecting link between the seat of intellect and the sensory and motor functions has been made by the minute study of such conditions as aphasia, and of this relationship Bastian has formulated (provisionally) a general law as a working hypothesis—viz., "The tendency to mental impairment with aphasia, and the degree of such impairment will, other things being equal, increase as the lesions of the left hemisphere, which produce aphasia, recede in site from the third frontal convolution, and approach the occipital lobe." The exact localisation of the excitable cortex is of the highest value in determining accurately the seat of discharging lesions, causing epileptiform fits, etc., but no matter how exact the study, or how accurate the inferences drawn therefrom may be, such data still leave us far from the localisation of mental phenomena. Let us now look more carefully at some of the facts before us, and let us endeavour to arrive at some conclusion as to how far we are really able to localise even the simplest mental state.

(1) *Phrenological mapping out* has proved of no value hitherto, and we are forced to acknowledge that phrenologists have not shown us anything that is verifiable.

(2) *Experimental research* has done much to determine certain physical relationships between cortical areas and afferent and efferent impulses.

(3) *Comparative anatomy* has also done much by demonstrating that differences of brain structure coexist with differences of mental faculty in races and species of animals. Meynert gives three anatomical facts which render a functional differentiation of the various cortical regions highly probable : (*a*) the develop-

ment of the olfactory lobe in different animals associated with the amount of use of the olfactory sense; (*b*) the difference in the relation between the median and the convex surfaces of the cortex in animals with strongly-developed olfactory lobes, and in man; (*c*) in the human brain the walls of the Sylvian fissure, are most highly developed. Man excels in the development of the regions associated with speech, and in the number of convolutions belonging to these regions, as animals with highly-developed olfactory lobes excel in regard to the size of these lobes. Therefore, he believes that the evolution of certain psychical functions goes hand in hand with a proportionate development of certain regions of the cortex. Other morphological points would apparently lead to the same view—*e.g.*, the quantitative differences in the brain trunks both in man and in animals dependent upon quantitative variations in the different parts of the forebrain, giving the idea of a harmonious dependence between the form of the brain-trunk structure and the quantitative development of the forebrain.

(4) *Morbid anatomy*, or the noting of the effects of lesions in different parts of the brain. Kirchhoff* asks the question, "To what extent have focal diseases aided in our knowledge of the location of mental disturbances?" If we take into account only the lesions which interrupt the various conduction systems, we do not gain much knowledge as to the centres which are probably affected. Of the basal ganglia, the optic thalamus would appear to be more closely connected with the mental functions than the corpus striatum; inasmuch as the former alone undergoes atrophy in congenital absence of the cerebral hemispheres. Kirchhoff believes that the disturbance in the intellectual development of individuals, in whom the corpus callosum is absent, or only very small, indicates that the higher mental processes are not dependent upon the frontal brain alone, for in these cases the occipital lobes are mainly atrophied. In some idiots, also, who have imperfect development of the brain as a whole, it is impossible to localise satisfactorily. Nor does he admit of any further conclusion being drawn from the study of irregular development in the cortical layers, unless the area so affected is circumscribed. "For example," he says, "in a

* "Handbook of Insanity," p. 9.

few idiots the frontal lobes contained only very few pyramidal cells, which were distributed irregularly, so that it was almost impossible to distinguish the layers." In these cases the imperfect mental development may be attributed to the imperfect development of the frontal cortex.

Localisation of the Mental Faculties. — In the attempt to localise activities of the mind, some assert, that each of the ultimate microscopic elements of the grey substance (ganglion-cell) represents a distinct psychical element (sensation); others regard the brain as acting in its entirety, or at least through large areas.

Before granting that the mind has its seat in the brain at all, let us look at some of the reasons which have led to this conclusion.

(1) The brain (*a*) is an indispensable medium between certain changes in the peripheral parts of the body and corresponding changes in the states of consciousness; (*b*) it serves as a basis for the execution of the ideas and volitions of the mind. If nothing takes place here, nothing at the periphery of the body will come from the volitions; if anything wrong takes place here, all that goes on at the periphery will be wrong, and the mind will not get its volition executed. (*c*) The brain seems to serve as the special physical basis of the ideas and volitions of motion themselves. After experience in moving a particular member of the body has once been gained, that member may be lost; and yet, if the proper areas of the brain remain unimpaired, the ideas, feelings, and volitions connected with the movement of the lost member will still arise in the mind. The man whose leg or arm has been amputated can still feel it, can form the image of how it should be moved to be in this position or in that, and even will to have it moved. The leg is not, then, the organ of these ideas, feelings, and volitions (Ladd).

(2) If the cerebral hemispheres of animals are removed various effects are produced. Ferrier says there is little difference from the normal mental condition. Vulpian* found, that not only may a fish be urged to move by bringing an object before its eyes, but it would also avoid obstacles as if still possessed of a sense of vision. Steiner† said that the only difference was a greater tendency to impulsiveness, and less caution in those which had been operated upon; further, not only do they see their food, but discriminate between the different kinds of food.

* "Système Nerveux," p. 669.

† "Die Functionen des Centralnervensystems, Zweite Abtheilung," Die Fische, 1888.

It is often difficult, so far as their movements and response to peripheral stimuli are concerned, to distinguish between a normal and a brainless frog. Ferrier believes that, if the observations of Goltz and Steiner are correct, the principal points of distinction between the brainless and the normal frog—namely, the absence of spontaneity and the power to feed itself, which are said especially to characterise the former—are no longer capable of being upheld, and that the brainless frog behaves precisely like the brainless fish.

Longet believed that the removal of the cerebral hemispheres annihilated only perception proper, as distinct from crude or brute sensation, which had its centre in the mesencephalic ganglia.* Ferrier says that, if the results obtained by Schrader are correct, we must class birds with fishes and frogs, which retain their sense of sight and guide their movements accordingly, even when the cerebral hemispheres are removed.

In animals generally, there are great variations, according to their lowness in the scale. Adaptive reactions appear to be better organised in the mesencephalic and spinal centres in fishes, frogs, and pigeons than in the lower mammals, and least of all in monkeys and man.

Can we infer, from the adaptive actions of the lower centres, that there is intelligence at the root of those actions? Ferrier believes that facts lead to the conclusion that between the simplest reflex action and the highest act of intelligence there is no essential difference, the one passes by insensible gradations into the other. He says we can infer only; we can prove nothing. We can say that the activity of the lower centres does not affect the consciousness—as in lesion of the internal capsule, when the sensory tracts are cut off from their cortical connections. The individual has absolutely no consciousness of impressions made upon his organs of sense, so that we may conclude that, in man at least, states of consciousness are indissolubly connected with the activity of the cerebral hemispheres.

Further, says Ferrier, "one may remove, anteriorly or posteriorly, from above, or from the side, a considerable portion of the cerebral lobes without destroying their functions. Even a small portion of these lobes, therefore, suffices for the exercise of their functions. In proportion to the extent of the removal, all the functions become impaired and gradually fail; and beyond certain limits they are altogether annihilated. The cerebral lobes, therefore, co-operate as a whole in the full and complete exercise of their functions. Finally, when one form of perception is lost, all are lost; when one faculty disappears, all disappear. There are, therefore, no special seats, either of special faculties or special perceptions. The faculty of perceiving, judging, and willing one thing resides in the same region as that of perceiving, judging, and willing another; consequently, this faculty, essentially one, resides essentially in one organ."

* Flourens, "Système Nerveux," 1842.

Certain areas of the cerebral cortex do appear to be concerned with the execution of certain functions of the mind. We cannot regard the mind, in its special relation to the brain, as limited to any point or small area of the cerebral cortex. Nearly all observers are agreed that considerable parts of the cortex can be destroyed without impairment of any of the special functions or faculties of mind. In fact, there is nothing to indicate that the mind depends upon cerebral activities concentrated in any one minute circumscribed spot. Goltz,* Munk, and Flourens agree in thinking that the most important cerebral functions, from which we conclude mental functions, cannot depend on definite sections of the cerebrum.

If we accept the doctrines of the more recent English school—that individual sensations or ideas exist only as members of a connected, conscious series, and that consciousness, therefore, can never be conceived as a mere sum or mere product;† and if we believe with Hume that consciousness is a mere succession of ideas without inner bond or connection, or that it is the series of our actual sensations (John Stuart Mill), it may be thought possible that there are individual nervous elements which possess isolated and distinct forms of consciousness.

From pathological conditions we do not appear to obtain evidences which may be termed conclusive; nor do such evidences prove to us that consciousness is confined to any supreme part of the cerebral cortex. Gowers‡ says, "With the much disputed question of the relation of mind to brain, the physician has nothing to do. It is enough for him to recognise that mental manifestations and cerebral activity invariably coincide, and that the character of cerebral processes in some way determines mental states. In the study of diseases of the brain we are concerned only with cerebral processes. Unfortunately, however, the chief terms available are those of psychology, and we are obliged, therefore, to speak of mental processes when all that we need speak of, and are, indeed, justified in speaking of, are cerebral processes. How-

* "Pflüger's Archiv.," xxvi. p. 35.

† Höffding, "Den engelske Filosofi i vor Tid," Copenhagen, 1874.

‡ "Diseases of the Nervous System," p. 98.

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ever undesirable such a confusion may be, it is practically unavoidable.* What are the cerebral processes which invariably coincide with mental manifestations? Can we imagine any one cerebral process, or set of processes, which coincide with any one mental state or group of mental states? Until we are in a position to answer these questions, it is obvious that we are, in reality, not in a position to speak of mental processes solely as cerebral processes. Nor do we know where to look for the junction of these cerebral processes with their "coincidental" mental processes.

The pathological data with which we are furnished, are, however, by no means to be ignored. Cases in which there has been complete destruction of one cerebral hemisphere, without mental disturbance, have suggested the possibility of vicarious activity of the other half of the brain, provided that both halves possess originally the capacity for exercising the same function. Kirchhoff regards this question of the co-ordinate value of the hemisphere as of the highest importance in the examination of the site of individual functions. Similarly, in aphasic conditions, the consideration of the physiological variations in the course of speech conception, is of manifest importance. Further, although (as we shall see presently) we are not in a position to say that conscious movements originate in the motor centres; these centres, nevertheless, constitute stations, or connecting links, for the transmission of such processes; hence, with disease or destruction of these areas, there is a tendency to restriction of the objective manifestations of consciousness. In the same way, affections of the so-called sensory areas may restrict or modify the amount or quality of sensory representations in consciousness. In fact, although we cannot bring pathological processes into direct apposition to morbid mental processes, we can conceive, on a lower platform, various conditions of disease which lead, in an unknown way, to restrictions and variations in the phenomena contained in that highest of all platforms—the seat of human consciousness.

Speaking of the difficulties of nerve-conduction through the

* The facts with which the alienist has to deal are in the main psychic facts.

network of fibres in the grey substances, Meynert points out, that we may infer that this enlarged surface will be able to perform a number of totally independent functions; that a sensory perception, for instance, need not give rise immediately to a motor act. Every spinal cord segment embraces the whole of the grey substance, whereas sections through the cortex contain but a small portion of the cortical grey. This distribution of grey substance will naturally prevent the entire cortex from acting to one single end, while it favours the isolated action of various cortical regions. Irradiation of functions is facilitated in the grey substance of the spinal cord, and rendered difficult in that of the cortex. Further, purely morphological data and a single pathological anatomical fact will enable us to determine which regions of the cortex, in the probable division of labour, take upon themselves centrifugal functions in the sense applied in Bell's law. The expression "*irradiation of functions*" at once suggests a clue to our actual pathological position, and we are forced to confess, that pathology, so far, has truly served to demonstrate the implication by disease of the sites concerned with the irradiation of functions, and not of the actual ultimate site of consciousness. Our position, therefore, is only a step higher in the confirmation of Bell's law, of the conduction of nerve-force in a centripetal direction through the posterior, and in a centrifugal direction through the anterior spinal roots.

In our attempt to find the site which is concerned directly with consciousness, we have explored various sensory and motor regions from an objective and physiological point of view. Before leaving these regions, however, let us really make sure that we are justified in concluding that consciousness is not ultimately determined in this sensory or motor platform—*i.e.*, can we find any reason which would justify the belief that any subjective condition or state of consciousness may arise directly from the objective functioning of the so-called areas of sensation and motion without the aid or collaboration of other still higher centres? First of all, let us try to answer the question, Are the so-called "motor centres" and "sensory centres" really the centres for pure motor and sensory events? or, as put by Waller, "Have we reached any true dead end to knowledge in the conclusion that the cerebral cortex contains 'sensory centres' and 'motor centres,' and, if so, what signification do we attach to these final terms?"*

On the question as to whether excitation-effects are caused by direct action upon particular centres in which the voluntary motor impulse arises, or whether they are attributable to an excitation of subjacent fibres, or whether any third possibility exists? Hitzig† says,

"Even if we assume as proved that the movements in question are liberated by the ganglionic substance—and it is not proved—this would not be enough to prove that with these movements which are liberated by the internal event, that precise portion of the cortex furnishes the substratum of the first outward step in the series beginning with the origination of a sense-impression, and finding a temporary end in the expression of will evidenced as muscular movement.

"It is, on the other hand, far from inconceivable—and the notion is favoured by our knowledge of the anastomotic structure of these parts—that that portion of the brain which includes the birthplace of a will to move is of another, or perhaps of a more complex nature, and that the parts which we have called centres only constitute agencies, exchanges, in which an arrangement of muscular movements occurs, similar to that effected through the grey matter of the spinal cord and basal ganglia, but more purposeful."

From experiments made upon two dogs, from which portions of the motor areas were removed, Hitzig concluded that the animals in question, after the operation, had only an imperfect knowledge of the state of the affected limb, and that they had lost the power of forming complete representations of it.

"Still," he says, "it is clear that very exact representations of the state of muscle must be produced—as we learn from these very images of movement—and it is equally clear that these images are attributable chiefly to the perception of the muscular stage and only in minor degree to joints, skin, etc., this we learn from the well-known illusions of movements occurring in the paralysis of the ocular muscles.

"If, nevertheless, our representations of the muscular state of our own body do not overstep the threshold of distinct consciousness, and thus enable us to see into the true nature of the process, we must attribute this failure to a very general law. We are able to distinguish

* "Brain," 1892, p. 333.
† "Brain," 1892, p. 135.

the state of particular organs only in so far as is necessary and sufficient for their use in the uninterrupted maintenance of their functions.

"But within such limits the apprehension of these mainly unconscious representations of each particular phase of movement, constitutes one of the necessary conditions of a normal progress of its succeeding phase; subsequently (considering apparent muscular repose as a phase of movement), one must recognise that muscular states in general are among the various causes that guide the organism in its voluntary movements, and that regulate these movements. Let us assume an entire absence of all other sensory stimuli and perceptions, so that we have to do with a simple motor machine of such a kind, set in motion by the muscular impulse, we may then very well imagine it as sufficient for the execution of purposive movements.

"We have recognised in the above-described portions of the cortex an organ, the function of which coincides with that aspect of the psychical phenomenon that we have been considering, and I do not see the necessity for admitting that will, as such, involves a specific and motor organ."

Munk * says, "Just as the cortex of the occipital lobes stands in relation to vision, and that of the temporal lobes to hearing, so the cortex of the parietal area stands in relation to common sensation (Gefühlsinn); in this, as in the other cases, we have the locus where perception is consummated, and where representations—the memory images of perceptions—have their seat. Let it be clearly understood, however, that it is not sensation of the skin only that is here in question, but sensation in its broadest sense—the sensation of the whole body." Further, he asks, "What are the organs, of which the modifications can reach consciousness as neural sensations? These organs are: the subcortical ganglia or centres in brain and cord, that invoke movements. As in the infancy of the animal, the representations of movement are developed from its first purely reflex movements; as in the adult animal, the representations of movements of a part of the body can still arise in its sensory area, even if (*e.g.*, in locomotion) this sensory area is not actually participating in the accomplishment of such movements; as, finally, the representations of movement lost in consequence of cortical extirpation in a given part of the sensory area, may be formed out of the reflex and automatic movements of the affected part, it cannot but be that fibres ascend to the cerebral cortex from subcortical motor centres or ganglia, as well as from the skin and from the muscles—the fibres that subserve cortical perception of these subcortical centres.

"Our neural sensations are indeed, for the present, to be distinguished from what has hitherto very generally received the name of neural sensation (Innervationsgefühl)—from the 'perception of the intensity of voluntary effort in connection with voluntary movement,' 'will,'

* Du Bois-Reymond, "Archiv.," 1878, p. 162.

'voluntary movement,' with seat and origin in the cerebral cortex, are indeed very convenient, and may, therefore, also be, valid expressions, but they are destitute of a phenomenal physiological substratum. All we know of the cerebral cortex is, that it is the place of perceptions and the seat of representations. Beyond this, it is merely admissible to assume, as has been assumed by Meynert on somewhat different data, and by Wernicke, that representations of movement are the causes of so-called voluntary movements; that with the production of such a representation to a given degree (and, indeed, with a production *via* sensation, not *via* its ordinary constituent sensations) *eo ipso* the corresponding movement is elicited; and that the greater its formative representation the greater the resultant movement. The 'perception of voluntary effort, in connection with voluntary movement,' might, indeed, be the attribute of a representation of movement; a true perception might still obtain only indirectly, quite independently of the 'will,' and the percept would then be nothing but the neural sensation in the sense just set forth."

Waller adopts the view that every centre must be sensori-motor, and in the two different components of the double term he does not recognise any phenomenal division of the central process into sensory and motor. He says,

"Between centripetal and centrifugal impulses I see a single psychical process, one and indivisible; to call it sensory or to call it motor, or even to call it sensori-motor, are, to my thinking, imperfectly and improperly to designate it by more or less subjective terms, with more or less obstructive connotations. All that I can recognise in the notion of a centre is an organ of elaboration receiving and giving out impulses. By the term motor I denote that it emits but fail to denote that it receives; by the term sensory I denote that it receives (and imply that it feels) and fail to denote that it emits impulses; by the term sensori-motor I denote reception, 'feeling,' and emission. All these meanings when closely analysed are illegitimate, and convey too little or too much. Experimentally I may not predicate 'feeling' of any centre, but only of the hypothetical *ego*, I may only infer from visible movements that other animals 'feel,' and that sensations similar to my own are associated with the activity of certain centres.

"I picture a wave of change passing through a cell, but do not know at what transverse section of the wave to label it 'motor' or 'sensory.' The property of cortical grey matter is senso-motivity; the most typica so-called motor cortex is senso-motor; the most typical so-called sensory cortex is senso-motor.

"A central process is not sensory or motor, but senso-motor (in a guarded sense), and a centre is an 'organ of return of action.'

"By those who make a distinction and contrast between a motor and sensory process, the motor idea is a mental picture of *movements about* *to be made*, the kinæsthetic idea is a mental picture of movements *just made*. The motor idea is considered as an antecedent to motion, the sensory idea as its consequent.

"It is not possible to distinguish a 'kinæsthetic' image of past movements from a 'motor' image of impending movements. The two words denote one thing. Nevertheless, we can and do recognise in the use of the word senso-motor, which connotes the notion that the centripetal generates the centrifugal phenomenon, the principle that phenomena have generators and consequent antecedents; we are reminded by the word that a centre is an organ of return of action and that the type of all motor action is a reflex act. This principle is recognised by all leading workers and thinkers—by Hitzig, in his conception that the motor area of the cortex is a 'muscular sense' area; by Munk, in his conception that it is the motor 'Fühlsphäre'; by Bastian, in his conception that it is the centre of 'kinæsthetic' impressions. These three conceptions are but one and the same conception, which I most explicitly and unreservedly accept as a fundamental article of thought."

Waller points out that his remarks do not directly involve any question of actual localisation. Its main arguments are equally applicable, whether senso-motility be the property of the entire cortex or of only its Rolandic area, whether we admit motor and sensory centres as taught by Hitzig and by Ferrier, or the cortical map of Munk, or indifference of function in the unrestricted sense of Flourens, or in the restricted sense of Goltz.

In whatever light Waller looks upon this question, his remarks—"Thought of movement is memory of movement, or, more generally, the *thought* is the *remembered*. An impulse, an intention, a resolution; a prayer is a more and more concentrated act of attention, of memory, of thought. An identical neural process is the essential phenomenon wrapped up and presented in these very different words: will, attention, memory, belief, thought"—would appear to infer such functional attributes to the Rolandic area of the cerebral cortex—*i.e.*, to a region essentially sensori-motor in function. He also disagrees with the exclusion of the motor zone from the sphere of consciousness, as enunciated by James, Bastian, Ferrier, Gotch, and Horsley. To James's comparison of the motor area to the mouth of a funnel (through which pour outgoing impulses, caused by incoming impulses) he also takes exception, at least, in so far as the theory holds that the functions of the structures at the mouth of this funnel may be only those of consciousness of the kinæsthetic ideas and sensations, and that this consciousness accompanies the rise in activity of them rather than its discharge. To James's hypothesis that these paths all run one way—that is, from "sensory" cells into "motor" cells, and from motor cells into muscles, without ever taking the reverse direction—he agrees; whilst with the statement, "All cells are 'motor;' we simply call those of the Rolandic region—those nearest the mouth of the funnel—the motor cells *par excellence*," he agrees, "most unreservedly." Further, he says, "Any motor or discharging centre must also be a 'sensory' or receiving centre; it must be excited as well as excite. Any 'sensory' centre must also be motor, directly or indirectly; else we could have no objective tokens of sensation; every centre, whether called motor or sensory, is *terminus ad quem* as well as *terminus a quo*."

Let us add to these views those of Meynert—viz., "Actual *sensation* is developed by the evolution of equally unknown external forces, which we must suppose differ very materially from one another. Nerves and nerve-cells possess no motor power. Indeed, there is nothing more certain about the functions of the cerebral organism, than that the centripetal sensory nerves are the keys which wind up the mechanism connected with the muscles, and excite the latter to action.

"A varying functional energy of brain-cells, according to the special organ of sense with which they may be connected, is quite indemonstrable, since we are acquainted with the physiological conditions favourable to the action of external forces, and can prove easily enough that it devolves upon the terminal organs of the nerves to meet these conditions.

"Specific energies, therefore, depend altogether upon the peculiarities of the end organs, and *sensitiveness is the only specific property of brain-cells*."

Conclusions.—What are we to learn from these controversies? Are we, after all, any the better able to come to any conclusion as to whether consciousness exists, as such, in the areas we have considered? or is some higher area essential to the psychical events? If we look upon the so-called sensory and motor areas as containing the structures which have *sensitiveness* (by this we do not imply any psychical correlate or state of consciousness) and the power of furthering, or even adapting, forces in a determinate direction; and, if we regard this physical apparatus more as a further advancement in complexity of the fundamental reflex power, it is obvious that the areas of such activities are only in a degree more closely approximated to the actual site of consciousness than other centres on a lower level in the cerebro-spinal system. From experimental investigations upon animals, it may be gathered that extirpation of a certain region, or regions, is followed by total loss of sensori-motor functions, as viewed objectively, but this is no guarantee that subjective psychical conditions are not still present. On the other hand, just as we may have complicated adaptive movements of exceeding fitness performed by the animal whose cerebrum has been destroyed, so we may have complicated mechanical, and even, apparently, intellectual performances brought about on a higher level without the slightest evidence of any conscious psychical correlate. By this is meant, that *fitness of reaction is no sure evidence of immediate conscious guidance.* The functions of the so-called sensori-motor areas, therefore, can furnish us with no more proofs of their being ultimately concerned with consciousness, than can the activities of lower centres which possess the same fundamental properties, although developed in a lesser degree.

The theory of reflex action, as first applied to explain cerebral processes by Laycock, has been very generally accepted. He did not, however, attempt to explain why some of the most complicated cortical processes were attended by consciousness and others not. He viewed the objective and subjective phenomena as correlated in some, but he did not seek to establish a direct or local correlation of the phenomena in a definite area, nor did he seek to explain either phenomenon in the terms of the other. The well-known views of Hughlings-Jackson, that the sensori-motor apparatus of the cortex is re-represented in other centres higher in the scale than the physiological sensory and motor areas in the cortex, find the most favour with those who have obtained an intelligent grasp of this subject; and, if we accept his view, that mental operations are simply the subjective accompaniments of sensori-motor processes, we do not, at the same time, in any way bind ourselves to the possibly erroneous conception that such subjective accompaniments are in immediate local juxtaposition to the physical sensori-motor processes. We have an abundance of examples of complex reactions with which no psychical correlate is apparent; and it is readily conceivable, that just as the nervous apparatus of lower centres is characterised by its sensitiveness and tendency to propagate its functions in a fit and appropriate direction, so the mechanism of the sensori-motor regions is characterised by its still more highly-developed sensitiveness and tendency to react to special stimuli conveyed through the medium of the special senses. On this assumption, and on this only, can we seek an explanation of many morbid objective manifestations as seen in the insane. In the early stages of the general paralytic, the occurrence of paralysis of his sensori-motor apparatus, as viewed by us objectively, without implication of the consciousness or totality of his mental being, as viewed by him subjectively; or in the acute maniac, whose sensori-motor apparatus furnishes us with objective manifestations of its abnormal activity; or, again, in the active physical phenomena of sleep, epilepsy, and hypnotism: all these may be explained from a sensory-motor point of view, and without any obvious psychical concomitance. It is characteristic of the human consciousness, that it exists as such over and above all physical processes; and, as yet, we are far from the possession of one fact, nay even one valid argument, in support of the conception, that the mind has its ultimate dwelling place in any one definite structure contained within the so-called sensori-motor regions of the cerebral cortex. When we discuss the questions as to whether revived images are gathered together into a special ideational centre, or whether they are merely taken cognizance of by the intelligence while remaining in their own situations, we shall see that the evidence stands in favour of the latter view. Some observers advocate that the intelligence is more especially connected with the superficial layers of the cortex; but even this supposition is not supported by evidence which can be regarded as conclusive.

CHAPTER IV.

LOCALISATION OF THE MENTAL FACULTIES—(*continued*).

Sensory and Motor Areas subserve Mental Events—Localisation—Diffuse Localisation—Indifferentism—The Frontal Lobe—Intelligence not limited to Local Areas—Ratiocinative Theories: Neural Inference Scheme of Hughlings-Jackson; Meynert's View of the Forebrain; Waller's View, based upon Psychological Inference—Value of the Logical Mode of symbolising Neural Inference—Præfrontal Lobes: Experimental Researches; Pathological Evidences—Consciousness pertaining to Lower Centres—Local Memories—Subjectivity of the Mind—Objective Contents of Consciousness—Specific Functions of Nerve-Cells—Wallerian Scheme of the Four R's—Specific Quantifications of Motion—Negative Value of Physical Formulæ—The Doctrine of "Invariable Concomitance."

AT the close of the preceding chapter we stated that the perception of different sensations was not proved to be consummated within definite parts of the so-called sensori-motor areas. We mentioned, for the purposes of the student, the hypothesis of Hughlings-Jackson, and others, that in addition to the regions which have been defined as sensory and motor, there may be other and higher motor as well as sensory centres, within which all the motor and sensory functions are again represented, and which form the substrata of the higher mental functions. This hypothesis, according to Ferrier, receives no confirmation from the facts of experiment; nor does he regard it as at all necessary to explain the facts of normal or abnormal mentation. "We have in the sensory and motor centres of the cortex the substrata of the respective forms of sensory perception and ideation, and of the individual acts of volition, simple and compound, as well as of the feelings associated with their activity. It seems more reasonable to suppose that there may be higher and lower degrees of complexity or evolution in the same centres, than to assume the separate existence of more highly evolved centres, for which no evidence is obtained by the results of experimental research."*

Of this latter view no criticism is necessary, for it has not yet been proved that a *centre* for *sensation* and another for *motion* exists in the cortex; and even though such centres did exist, we are very far from forming any conception as to *the actual substrata of the respective forms of sensory perception and ideation, and of the individual acts of volition.* We are, to a limited extent, cognisant of the physical conformation of the brain structures; we know that there are paths of conduction for stimuli of various kinds, and we know that stimuli do pass along those paths and may be reflected in their course by structural realities, but beyond this we can conceive no intimate or ultimate substratum which directly serves consciousness. In fact, when we speak of the substrata of perception, ideation, and volition, *as applied to the cerebral cortex*, we can only realise, that we have advanced one step onward in our search for the structures which are immediately concerned with modes of consciousness, and that we are still on a level which offers little or no clue to the whereabouts of what we seek. The words of Herbert Spencer†—viz., "Whoever calmly considers the question cannot long resist the conviction that different parts of the cerebrum must, *in some way or other*, subserve different kinds of mental action"—contain the pith of our knowledge of the whole question. The different parts of the cerebrum, as well as the whole physical organism, do subserve different kinds of mental action, but they only *subserve*, and we cannot as yet determine where or how the different kinds of mental action are ultimately *served*. Our position, in regard to the areas we have already investigated, therefore, is this, *they, in some way or other, subserve the different kinds of mental action.* Further, Herbert Spencer says, "Localisation of function is the law of all organisation whatever; and it would be marvellous were there here an exception.

* Ferrier, "Cerebral Localisation," 2nd edit. p. 460.

† "Principles of Psychology," 1870.

Either there is some arrangement, some organisation in the cerebrum, or there is none. If there is no organisation the cerebrum is a chaotic mass of fibres, incapable of performing any orderly action. If there is some organisation it must consist in that same 'physiological division of labour,' in which all organisation consists; and there is no division of labour, physiological or other, but what involves the concentration of special kinds of activity in special places." An analysis of this statement in no way invalidates, or tends to check, the course of our thoughts. It involves both physical and mental activities. Of the attempts to localise physiological activities we have only to mention those of Ferrier, Schäfer, Horsley, Beevor, Charcot, Déjerine, Goltz, Wundt, Munk, Hitzig, Schiff, Bastian, Hubnoff, Heidenheim, and others; and from the results of their labours we cannot but recognise the law of the tendency to local differentiation of physical activities. When, however, we pass from the objective manifestations of these activities, and endeavour to superimpose upon them various psychical states, we almost immediately get beyond our depth, and flounder amidst all sorts of conjectures and hypotheses. These hypotheses may be ranged under two classes—viz., (1) those which favour the view of localisation; and (2) those which support the idea of diffusion of function ("diffuse localisation," or "indifferentism"). But, the student will ask, Are we not still upon too low a platform of our organisation to entertain, for the present, such questions? We are on the platform of the so-called sensory and motor centres; we are dealing with the physical substratum (so far as we know it) of the special senses; and we are surveying the site which we have already granted, "in some way or other, subserves" consciousness.

What we have now to decide is, do the elements of these physical substrata directly and within their own domain serve consciousness with the phenomena of sensation? or do they subserve it by a furtherance or propagation of their physical conditions to other regions where their activities are ultimately correlated with consciousness? Herbert Spencer advocates, that a perception can have, in a nerve-centre, no definite localisation, but only a diffuse localisation. No one excited fibre or cell produces consciousness of an external object: the consciousness of such external object implies excitement of a plexus of fibres and cells.* Wundt objects to the view that sensations take place in the separate areas which are now regarded as sensory centres, inasmuch as such a belief would countenance the old phrenological faculty scheme. His doctrine of a frontal organ of apperception might appear to receive ample confirmation from the experiments of Ferrier, and from the reasonings of Hughlings-Jackson. Let us, therefore, go elsewhere in our search for some more highly evolved substratum, than that of the chaotic mass of tracts and junctions contained within, what we term, the sensory and motor areas.

The exclusion of the motor zone from the sphere of consciousness—enunciated by James, and approved of by Bastian, Ferrier, Gotch, and Horsley—has been objected to by Waller. The supposition that consciousness accompanies the rise rather than the discharge of activity in these regions in no way implies that the sphere of consciousness exists actually in them. The consciousness accompanying their activities is to be regarded as a collateral manifestation of the activities propagated in some unknown way from these regions to other regions which are more directly concerned with the phenomena of consciousness. That is to say, we have not, as yet, arrived at the conclusion that there exists a more highly evolved centre, with the activities of which the respective forms of sensory perception and ideation, the individual acts of volition, simple and compound, and the feelings, are more directly associated. It does, indeed, seem reasonable to assume that there may be higher and lower degrees of complexity of evolution in the nervous structures; but we have, as yet, no conclusive proofs, either that the various degrees of evolution occur in the same centres, or that there exist separate or more highly-evolved centres for the physical correlates of mentation.

The **frontal lobe** contains a non-excitable area of cortex, which is situated in front of the area for the representation of the head and eyes, and, in the monkey, is bounded posteriorly by a vertical line drawn through the anterior end of the horizontal limb of the præcentral sulcus, from the median line down to a point a few millimetres in front of the anterior end

* "Principles of Psych.," 2nd edit. 1870, p. 562.

of the fissure of Sylvius.* This part of the brain is considered by most investigators to be the seat of the highest mental processes. Meynert believes that within the *forebrain* sensitiveness is converted into actual sensation.

"The relation of the forebrain to the other parts of cerebral mechanism is easily understood. To this end we may recall the structure of the retina, which constitutes a hollow into which the visual rays from the external world are, as it were, entrapped. And, in the same way, we may look upon each half of the cortex of the forebrain as a concave organ, duplicated in parts, enveloping all the nerve-tracts, which conduct to it the impressions from the outer world. In this organ these impressions are converted into the phenomena of sensation. In assimilating totally unknown physical impulses, the cerebral cortex—a complicated protoplasmic structure—resembles the protoplasm of the primitive amœba, which can transform itself into a hollow mass, and can thus encircle any body which it wishes to assimilate. Just as the mollusca possess tentacles, which they protrude toward the outer world, and claws, by means of which they take possession of their booty, so this complicated protoplasmic organism—the prosencephalic cortex—possesses centripetally-conducting processes—the sensory fibres of the nervous system—which we may consider its tentacles, and motor fibres, which are its claws. The remainder of the body, with its sensitive surfaces, its muscles, and the skeleton to which these muscles are attached, serves to sustain these tentacles and claws, which enable the forebrain to receive the images of the external world, and to react upon the latter."

Munk regards the entire frontal lobe as a sensory sphere; and others have pronounced the frontal region to be the exclusive seat of intelligence. Meynert corroborates the view of Munk, and adds, that consciousness, and intelligence also, which are evolved in the forebrain, depend upon a mechanism, the minute details of which, if understood, would enable us to restrict intelligence to the forebrain.

From the experimental investigations of physiologists, we are led to believe that when the forebrain is extirpated, there is serious impairment of the intelligence of the animal. Goltz, in particular, has demonstrated that the loss of only a few grammes of substance of the frontal lobes of dogs was sufficient to produce what he regarded as a state of idiocy. Meynert holds, that the conclusions of experimental physiology strengthen the opinion that intelligence is not limited to defi-

* Beevor, "Tuke's Dict.," p. 156.

nite cortical areas, but that, being based upon perceptions, including the sensations of innervation, it results from the *activity of the entire forebrain.*

The belief that the exercise of intellectual activity by every part of the cortex depends upon the uniform structure of all parts of the forebrain, which makes of each part a centre for inductive processes, and supplies to each part nerve-elements capable of perceiving and receiving images, is unsupported by experimentation and pathology. All parts of the forebrain are joined to each other by anatomical association tracts, and the connections of these tracts with other functionally-perfect association tracts in other regions of the cortex, furnished some investigators with the idea of the presence in the brain of an induction apparatus; and, according to Meynert, the so-called logical sequence in the evolution of association, which yields the factors of intelligence, is effected in various ways, and to a varying degree of perfection, in different brains.

Let us here, however, briefly consider the arguments of those who have attempted to give a rational view of psycho-physiology.*

To Hughlings-Jackson† we are indebted for the **neural-inference scheme,** as given in his well-known "three level."

"(1) Evolution is a passage from the most to the least organised—that is to say, from the lowest well-organised centres up to the highest least-organised centres. Putting this otherwise, the process is from centres comparatively well organised at birth up to those, the highest centres, which are continually organising through life. (2) Evolution is a passage from the most simple to the most complex; again, from the lowest to the highest centres. There is no inconsistency whatever in speaking of centres being at the same time most complex and least organised. Suppose a centre to consist of but two sensory and two motor elements; if the sensory and motor elements be well joined, so that 'currents flow' easily from the sensory into the motor elements,

* The *ratiocinationists* (who deduce consequences or form inferences from the comparison of premises) follow more or less in the lines of Herbert Spencer, who says, "Every ratiocinative act is the indirect establishment of a definite relation between two things, by the process of establishing a definite relation between two definite relations."—"Psychology," vol. ii. p. 16.

† "Evolution and Dissolution."—"Lancet," 1884.

then that centre, although a very simple one, is highly organised. On the other hand, we can conceive a centre consisting of four sensory and four motor elements, in which, however, the junctions between the sensory and the motor elements are so imperfect that the nerve-currents meet with much resistance. Here is a centre twice as complex as the one previously spoken of, but of which we may say that it is only half so well organised. (3) Evolution is a passage from the most automatic to the most voluntary. The triple conclusion come to is, that the highest centres, which are the climax of nervous evolution, and which make up the 'organ of mind,' or physical basis of consciousness, are the least organised, the most complex, and the most voluntary. So much for the positive process, by which the nervous system is 'put together' —evolution."

His scheme of the *hierarchy of nervous centres* is arranged on an anatomico-physiological basis—that is, especially as to degree of indirectness with which each represents the body, or part of it.

"(1) The lowest motor centres are the anterior horns of the spinal cord, and also the homologous nuclei for motor cranial nerves higher up. They extend from the lowest spinal anterior horns up to the nuclei for the ocular muscles. They are at once lowest cerebral and lowest cerebellar centres; hence lesion of them cuts off the parts they represent from the whole central nervous system.

"The lowest centres are the most simple and most organised centres; each represents some limited region of the body indirectly, but yet most nearly directly · they are representative. The middle motor centres are the convolutions making up Ferrier's motor region and the ganglia of the corpus striatum. These are more complex and less organised, and represent wider regions of the body doubly indirectly; they are representative. The highest motor centres are convolutions in front of the so-called motor region. I say so-called, as I believe, and have urged for many years, that the whole anterior part of the brain is motor, or chiefly motor.* The highest motor centres are the most complex and least organised centres; and represent widest regions (movements of all parts of the body), triply indirectly; they are re-re-representative. That the middle motor centres represent over again what all the lowest motor centres have represented will be disputed by few. I go further, and say that the highest motor centres (frontal lobes) represent over again, in more complex combinations, what the middle motor centres represent. In recapitulation there is increasing complexity, or greater intricacy of representation, so that ultimately the highest motor centres represent, or, in other words, co-ordinate, movements of all parts of the body in the most special and complex combinations."

In regard to the scheme of the sensory centres his conclusions are—

* "Brit. Med. Journ.," March 6, 1869.

(1) That the highest (chiefly) sensory centres, parts behind Ferrier's sensory region, and also the highest (chiefly) motor centres, parts in front of the so-called motor region, make up the physical basis of consciousness; and (2) that just as consciousness represents, or is, the whole person psychical, so its anatomical basis (highest centres) represents the whole person physical, represents impressions and movements of all parts of his body; in old-fashioned language, the highest centres are potentially the whole organism. States of consciousness attend survivals of the fittest states of centres representing the whole organism

Meynert has endeavoured to prove a *logical sequence in the evolution of association.* He follows most authors in regarding the intensity of established associations, as dependent upon their conscious and frequent re-excitation. An accidental succession of impressions is seldom repeated, and relations thus established vanish quickly from the brain. As soon, however, as the "subjective bond of causality" represents an actual union of things, the re-occurrence of external stimuli will establish a permanent association within the brain.

The relation of one mind to another, and the effects of the transmission of approved impressions, is of great interest. Individual intelligence may grow from copying the psychical associations in the minds of others, but any real development of intelligence is only to be gained by the individual's own association of ideas. According to Meynert, projection and association are the two forebrain principles of concerted action, and such action constitutes an induction. In this way he seeks to demonstrate, that the widespread activity of the forebrain serves not only as the recipient, but also as the creator of sensations.

Wundt* called an induction the fundamental logical function; but Meynert† first tried to demonstrate the association and induction mechanism of the forebrain. He believed that both ends of the association fibres were connected centrally with cortical cells. The projection bundles, consisting chiefly of fibres of the corona-radiata, spreading into the medullary substance of the forebrain, conduct to the cortex the excitations from the external world, and distribute them over its different sensory spheres. All objects which, as soon as per-

* "Ueber Menschen und Thierseele."

† "Leidesdorf's Manual," 1865.

ceived, engage two different sensory spheres, may appear to prove the existence of an induction mechanism, present everywhere in the brain, and anatomically dependent upon the association and projection-systems; but, as we shall see later, the physical compounding of sensations is an unwarrantable assumption. Psychologically, the mind may receive an impression and then refer to the attributes of that impression, thus drawing upon the resources of different sensory spheres; it does not draw from two sources at once.

Waller* has endeavoured to demonstrate the essential similarity of neural processes concomitant with the whole range of subjective phenomena from the simplest sensation to the most complex judgment; but, as his starting point is with the ultimate fact "sensation," we do not in reality gain any further insight from his conception of the *physiological mechanism of ratiocination.* In analysing the factors of the simplest sensation, as well as of the most complicated judgment, he adopts the logical expressions, *major premise, minor premise,* and *conclusion.*†

In this scheme it is essential to avoid confusion, by distinguishing between subjective sensation and activity within the objective substratum of sensitivity. Viewing the subject from the centripetal aspect of neural processes, he appropriates to the three-level scheme the three terms, *impression, sensation, perception,* using "impression" as the lowest level term, and taking "impression" to denote an effect that does not reach consciousness; "sensation" to denote a felt impression; "perception" to denote a sensation in its felt consequence.

The scheme is based on the type of the **psychological process of inference,** and is as follows:—

The simplest present sensation σ is not the concomitant of any isolate present state of organ S, but the resultant of a comparison based upon state now and state before now—*i.e.*, of a ratio $\frac{S}{S^1}$.

The organic state now is the sum of many previous alterations of state; many sensations σ the concomitants of many previous ratios $\frac{S}{S^1}$, may be conceived as summed up in the state of sensibility Σ.

* "Brain," 1892, p. 355.

† Waller does not imply that the syllogistic terms of logicians correspond to any physiological factors in a neural process. The mental and physiological states are symbolised by Greek and Roman letters respectively.

This state of sensibility Σ has as its organic basis a material state, which (having regard to the total Σ by many elementary σ, each concomitant with a ratio $\frac{S}{S}$) is properly represented as the ideal symbol $\frac{S}{S^1}$.

Thus Σ the specific sensibility, the subjective resultant of past experience, is the concomitant of $\frac{S}{S^1}$, the imaginary organic sum of the antecedent series of organic ratios $\frac{S}{S^1}$.

To this resultant state (subjectively Σ, objectively $\frac{S}{S^1}$) he applies the term "personal ratio," meaning to connote in this expression, that the personal state now is composed of compared objective phenomena and not of *absolute* objective phenomena.

This personal ratio he takes to be the subjective attribute of the organic *major premise*, each new sensificatory change of state he regards as a *minor premise*, and considers that a *conclusion* is formed by the compounding of these two premises; this compounding or neural inference may, he thinks, properly be represented symbolically in the form of a multiplication, in which the product represents the conclusion, and at the same time the new major premise in relation to subsequent minor premises.

$$\frac{S}{S} \times \frac{S}{S^1} = \frac{S\,S}{S^1S^1} \text{ or subjectively } \sigma.$$

But here it is necessary to justify the transition from the use of the word "ratio" to that of the word "premise," and the use of a fractional symbol for both words.

The terms of any premise or proposition are the subject and the predicate (joined by the copula); in a major premise the subject enumerates and the predicate denominates. The major premise "all men are mortal" may be written $\frac{\text{all men}}{\text{all mortals}}$, in which we enumerate "all men" as forming part of "all beings denominated mortals."

The minor premise "*Socrates is a man*" may be written similarly $\frac{\text{Socrates}}{\text{men}}$, by which we enumerate Socrates as belonging to the denomination men just enumerated in the subject of the major premise. And the syllogism may be written :—

$$\underset{\textit{major}}{\frac{\text{men}}{\text{mortals}}} \times \underset{\textit{minor}}{\frac{\text{Socrates}}{\text{men}}} = \underset{\textit{conclusion.}}{\frac{\text{Socrates}}{\text{mortals}}}$$

It would be absurd to say that this or any other mode of symbolisation "explains" judgment, attention, sensation; but it is not too much to say that it clearly exhibits the possible factors of neural inference; each act of observation, each determination of conduct, is the resultant of two factors: (1) the major premise or central state, more or less attended to; (2) a particular minor premise or group of sensificatory stimuli, also more or less attended to (within the remaining sensificatory field, less or more attended to).

Value of the Ratiocinative Method.—The logical mode of symbolising neural processes may serve a purpose; but, inasmuch as the particular premises—major and minor—are manifestly mental, and only (at least so far as we can imagine them to be) correlates of *ultimate* physiological factors, the whole scheme resolves itself into a disquisition upon the ordinary rules of the syllogism, with, in addition, the conception that the physical organism in some way or other subserves the phenomenon of sensation. We shall have occasion to discuss at some length the various theories given to explain the correlation, or, as materialists would say, the "evolution" of a major or minor premise as a sensation in consciousness, and we shall see that the objects of consciousness, as viewed objectively by the subject, are the data, or premises, upon which our conclusions are formed. Here we anticipate by assuming, that the various presentations and representations in consciousness are correlative states to physiological activities. Every presentation and representation is an objective content of consciousness, and each content in itself forms a major or minor premise. For an explanation of the formation of that major or minor premise, we must have recourse to metaphysics or philosophy. On the psychical side we have the contents of consciousness, which furnish us with data from which we infer our conclusions. On the physiological side we have various activities which resolve themselves into reflex acts, the results of transmitted excitations. It must suffice for the present to recognise that the sum total of the complex physiological activities becomes manifested as an objective content of consciousness, and that the *ego* does not view the activities themselves; it merely views their mental correlates as objective states.

The study of the nervous mechanism has disclosed to us that just as our bodies are associated with the activities of the cosmical system, so our organic nervous structures are associated with the objective phenomena of consciousness. Further, the details of physiology and anatomy would appear to point to the fact that some ultimate and intra-bodily activity is essential to, and possibly conditions every diversification of, the sensory and other kinds of experience. Beyond this we cannot go. The mere experience of sensory consciousness in itself affords us no scope for ratiocination. In other words, we believe that our cerebro-spinal system is capable of receiving and of propagating specific agitations, and also of exerting, in some way or other, a determinate modification of activity in its substance; but we do not in the least degree understand the *modus operandi* whereby we experience the current vicissitudes of consciousness.

Experimental Researches.—We may now return to the consideration of the *præfrontal lobes* which have been regarded as especially the seat of intellectual operations. At the International Congress of Experimental Psychology, held in London in 1892, Schäfer challenged the results of the earlier experiments made upon monkeys by Ferrier. In conjunction with Horsley, Schäfer found, after bilateral removal of the præfrontal lobes, that at first the animals appeared apathetic, but that this condition passed off after two or three days. He also regarded the experiments of Hitzig and Goltz upon dogs as doubtful, inasmuch as antiseptics were not used, and from the small size of the præfrontal lobes in these animals and their juxtaposition to the psycho-motor or kinæsthetic area, the symptoms might possibly have been due to an extension of the injury to that region.

In order to avoid the shock, consequent upon a bilateral removal of an extensive part of the hemispheres, which is apt to be temporarily followed by a condition of apathy and apparent idiocy, whether the operations be in the frontal or other regions, Schäfer adopted a modification of the mode of operating, whereby he did not actually remove the portions of the brain but severed their connections with the rest of the mantle and the brain-stem. In several instances in which he thus severed the præfrontal lobes in monkeys there were no appreciable symptoms. From these experiments he could not support the view that the præfrontal lobes were especially the seat of intelligent action.

Henschen has given an account of a young man who shot himself. The ball entered the right temple; after perforating the right frontal lobe, it passed back again to the frontal bone through the left frontal lobe. The man was able to get up and open the door for the police. He also walked downstairs and to the hospital. The whole day he seemed to be conscious; and he also spoke a little. At the post-mortem examination a large part of the nerve-fibres from the frontal cortex was severed, and hæmorrhage had taken place in the course of the bullet wound. An even more interesting case was admitted to Bethlem Hospital three years ago. A man who had suffered from melancholia, with suicidal tendency, shot himself through the roof of the mouth. The ball passed through the frontal region of the brain and emerged at the top of the frontal bone. After the shock of the injury had subsided, the mental condition continued precisely as before, and there was no obvious impairment of consciousness. Nor did the patient at any time manifest any confusion of ideas or subjective change within himself. Ultimately he recovered completely, and still possesses the right use of all his mental faculties. These cases would appear in accordance with the conclusion drawn by Schäfer, to demonstrate that the frontal lobe is not necessary for the higher psychical life. Gowers * says, "It is presumed that mental processes are subserved by those parts of the cortex that have no known motor or sensory function, and especially by the præfrontal lobes. Many cases are on record in which considerable mental change was produced by extensive disease of this part, especially great when the disease was bilateral. Small lesions, however, may cause no symptoms, perhaps because there is considerable capacity for functional compensation. It would probably, however, be wrong to regard mental processes, as exclusively related to the parts which are not known to have other functions, since the motor and sensory regions must also subserve mental operations."

Pathological Evidences.—From the numerous records of injury and disease, implicating the præfrontal region, we are almost bound to conclude that, inasmuch as such injury or disease is not attended by any definite impairment of sensibility or motility, the functions of this region are not essential to the phenomena of sensibility and motility, so far as they are evidenced in consciousness. That is to say, the functions of

* "Diseases of the Nervous System," p. 25.

the structures which *subserve* consciousness may remain unimpaired, and consciousness may be *subserved*, even though the structures which we imagine to directly serve consciousness be in great part destroyed. Referring to many of the recorded cases of injury, involving the præfrontal region of the brain, Ferrier* says, "I might multiply instances all demonstrating the fact, that sudden and extensive lacerations may be made in the præfrontal region, and large portions of the brain-substance may be lost, without causing impairment either of sensation or of motion; and, indeed, without very evident disturbance of any kind, bodily or mental, especially if the lesion be unilateral." Again, referring to a number of cases of softening and abscess in this region, he says, "In all these cases there was an entire absence of sensory or motor paralysis; and in many there was nothing recorded or nothing calling for special attention as regards the mental condition. In some of them, however, and in one or two others to be referred to, the psychological condition seems to have attracted notice." As we have before observed, the removal of the præfrontal lobes in monkeys, followed by alteration in the animals' character and behaviour, furnishes us with no definite proof that the subjective conditions of consciousness were interfered with; and it is quite possible that their consciousness was intact although their objective expressions were at variance. Bastian† says, "In regard to alterations in the mental condition, these may be either non-appreciable or slight in cases of injury of, or disease in, this brain region. Any such symptoms have been very frequently absent where there has been damage to the præfrontal region of the brain only on one side; whilst, on the other hand, alterations in the mental condition have been not infrequently noted when these regions have been simultaneously affected in both hemispheres. It has often been difficult precisely to define the nature of the change which has been brought about; but a dull apathetic condition seems to have been most frequently noticed, together with irritability, vacillation, a diminished power of attention, and a lowering of the moral nature."

* "Localisation of Cerebral Disease," 1878, p. 33.

† "Paralyses Cerebral, Bulbar, and Spinal," p. 250.

The following facts about a patient, who was an inmate of the Hospice de Ménage (quoted by Ferrier), are of interest. The lesion in this case was purely cortical, atrophic, and dependent upon partial obliteration of the arterial supply. It occupied the first, second, and third frontal convolutions, and also the internal aspect of both frontal lobes. The ascending frontal, ascending parietal, and paracentral convolutions were intact. The rest of the brain was normal except in the region of the inferior parietal lobule of the right hemisphere. During life his muscular powers and sensation were unimpaired. He was, however, in a state of complete dementia, marching about restlessly the whole day, picking up what came in his way, mute, and oblivious of all wants of nature, and requiring to be tended like a child.

Unfortunately, in this case, only the macroscopic changes were described, and, as pointed out by Bastian, there might have been microscopic changes in other parts of the brain similar to those met with in dementia. This conclusion is quite justifiable, and the mental symptoms may have been those of an ordinary demented patient, who presented, over and above what is usual, a definite gross lesion of the frontal lobes.

If we ask ourselves the question, Are there any definite signs by which we can, with any degree of certainty, come to a positive diagnosis that disease exists in either præfrontal region of the brain? we are forced to answer in the negative. In cases of external injury, disease in the nasal fossæ, or tumours of the orbit, we may be led to infer that the frontal region of the brain has become involved; but lesions originating in the frontal lobes themselves are unattended by any symptoms which have any localising value.

Instances in which the brain has been extensively diseased without the phenomena of mind being impaired in any sensible degree are exceedingly common. In such instances there may have been destruction of particular parts of the brain, or the cerebral mass may have been diseased or destroyed to a considerable extent. Ferrier mentioned the case of a man who died of an affection of the brain, and retained all his faculties entire till the very moment of his death, which was sudden.

On examining his head, the whole of the right hemisphere was found destroyed by suppuration. Diemerbrock records a similar case, in which half a pound of pus was found in the brain, without any obvious mental symptoms during life. Marshall has related the remarkable instance in which a man died with a pound of water in his brain, after having been long in a state of dementia, but who, a very short time before death, became perfectly rational. In the cases of idiocy recorded as having arrest of development, or atrophy of the frontal lobes, the condition has usually co-existed with similar defects in other regions of the brain. In general paralysis there is no evidence that the mental symptoms can be referred to lesions in the frontal lobe more than to lesions in other parts of the brain.

In fact, none of the pathological changes hitherto described enable us to understand the nature and mode of development of mental disorders. In other words, our knowledge of the functions of the human brain, and of the localisation of cerebral disease, is not yet sufficiently advanced to enable us to determine, with any degree of accuracy, the locality and nature of disease affecting the cerebral hemispheres, and still less are we enabled to localise the cerebral disease, which has morbid mental symptoms as its accompaniments.

The attempts to follow up the clue suggested by the localisation of the speech-centre in the left hemisphere have resulted in the belief, that the entire cortex is the site of language conceptions. Similarly with insanity, we have to resort to the belief that the lesions are diffused over the cortex. In speech-affections the mental disturbance is usually much more marked with diffuse disease than with focal lesions. In insanity generally, speech affections are more commonly due to diffuse lesions of the cortex. With our advance in knowledge, and improved methods of examining the brain tissues, we shall probably find that, in the main, mental disturbances are associated with diffuse lesions. Hitherto, the clinical facts of irritative and destructive lesions of some areas of the brain are in accordance with the data of experimental research ; but, as yet, such data are not sufficient to furnish precise regional indications. It must suffice for the present to say that we cannot diagnose lesions of the præfrontal region with any degree of certainty from the symptoms. The mental symptoms which may be observed in connection with such lesions are such that they cannot be distinguished from the general effects of other cerebral diseases, such as embolism, thrombosis, abscess, or tumour. It is obvious, therefore, that in order to come to some decision upon the question of localisation of mental events, it is essential that (1) the contentions of Ferrier, Charcot, Nothnagel—that there is no necessary connection between cortical lesions of the motor zone and affections of sensibility—should harmonise with those of Exner, Luciani, and others, who believe that sensory and motor centres coincide, and that cortical motor lesions affect common sensibility as well as motion; (2) the relations of the sense of movement to the cortical motor zone should be decided; (3) the functions of the other parts of the cortex should be more definitely known; (4) the conditions known as word-blindness, word-deafness, etc., should be more closely investigated. When we have gained an adequate knowledge of these physiological data we shall be better able to cope with the questions of mental physiology; but, in the meantime, we must not assign causes where causes cannot be shown to exist, or deduce extempore doctrines from a very partial view of the influence of cerebral disease upon the phenomena of the mind.

And so the examples afforded us by cerebral pathology do not warrant those partial deductions which form the basis of an irrational materialism. The mind holds intercourse with the external world through the medium of the nervous mechanism, and any disease of that mechanism may impair or suspend this intercourse. We have already mentioned instances in which the brain has been injured or diseased to an extraordinary extent, without any obvious impairment of the mental functions. Asylum workers almost daily witness the revival of mental manifestations which have been obscured for a time. In such instances the mind may revive with all its old vigour almost at the moment of dissolution.

From the above considerations it will be readily understood that some hallucinations and mental changes cannot be explained by physiological perversion. In subsequent chapters, therefore, we shall simply assume that disease of the cerebrum impairs or suspends the intercourse of the substantially unknowable mind with the external world.

Some writers maintain, that the præfrontal lobes are all-important in regard to the manifestation of what is known as "attention," and also that they are intimately concerned with emotional states. These views are unverified, and, as Bastian pointed out, it does not require much reflection to show us that an animal from which the præfrontal lobes have been removed may be dull and apparently careless of what is passing around it, when the incitements and first conditions essential for an alert observant attitude are wanting. Such an animal may easily seem to have undergone a very distinct mental alteration. Meynert's, and Jackson's view, that the highest centres do probably contain nothing but arrangements for representing impressions and movements and other arrangements for coupling the activity of these arrangements together, is, on the whole, the most satisfactory. James's somewhat broad and vague conception—that currents pouring in from the sense-organs first excite some arrangements, which in turn excite others, until at last a motor discharge downwards of some sort occurs, and that such streams of innervation are accompanied by consciousness, mainly of things seen if the stream is strongest occipitally, of things heard if it is strongest temporally, of things felt, etc., if the stream occupies most intensely the "motor zone"—seems in the right direction, but is not sufficient as yet to solve the mystery of the stability and depth of the mind, as evidenced in its mnemonic and subjective powers of recall.

Thus far we have seen that it is impossible to localise mental events within any definite areas in the brain. We know that the brain is the organ or instrument through which stimuli acting on the end organs of sense ultimately reach the mind. Sensations are states of consciousness; and we are as far off as ever from the conception of any brain activities which could give rise to them.

The question as to whether individual parts of mental operations are associated with definite parts of the cortex has, in the case of aphasia and allied conditions, assumed fairly definite proportions; but, at the best, we must remember, that the clinical manifestations in these cases may furnish us simply and solely with evidences that the physical paths of conduction, or the organic substrata, which in some way or other subserve consciousness, are not performing their physical functions satisfactorily. We have, on the one hand, to deal with mental activities of extreme complexity, to account for which we can imagine no specific functions in the nervous elements which would serve as a physical counterpart; whilst, on the other hand, we have a chaotic mass of tracts, cells, and other nervous elements, which, when viewed either singly or in combination, do not suggest to our minds any explanation of the very simplest psychical process.

Kirchhoff believes that all internal processes constitute consciousness, and that there are no individual modes of consciousness. The processes of consciousness are dependent on the entire nervous system, not on the cerebral cortex alone. Whilst recognising that mental phenomena are entirely dependent upon the physical organisation of the nervous system, we are at present entitled only to say, that the cerebral cortex appears to have a more direct and more intimate relation with the phenomena of consciousness than is manifested by other regions of the cerebro-spinal system. But of that cerebral cortex, we cannot point to any one part as containing the absolutely essential elements to thought in its subjective aspects.

James asks, "Is the consciousness which accompanies the activity of the cortex the only consciousness that man has? or are his lower centres conscious as well?" In attempting to reply to this question he fully recognises the difficulties, but states, "The lower centres themselves may conceivably all the while have a split-off consciousness of their own, similarly ejective to the cortex consciousness; but whether they have it or not can never be known from merely introspective evidence. For practical purposes, nevertheless, and limiting the meaning of the word consciousness to the personal self of the individual, we can pretty confidently answer the question by saying that *the cortex is the sole organ of consciousness in man.* If there be any consciousness pertaining to the lower centres, it is a consciousness of which the self knows nothing."

But the possibility of consciousness pertaining to any of the lower centres is not to be estimated by the complexity or fitness of the reactive manifestations as viewed objectively, otherwise we are free to assume the existence of consciousness in still lower centres of the cerebro-spinal system; for, as is known to be the case, such lower centres are capable of effective reaction apart from cerebral influence. The facts, as presented to us by a study of the evolution of the central nervous system, would lead us to the conception, that our physical organism is eminently adapted to react to stimuli derived from our environment; and of our physical organism the central nervous system is the more immediate means of effecting such reaction; it is through this nervous system that the outside world is perceived subsequently by the mind. Beyond this we cannot go. A satisfactory reply, as to whether the activities of the lower or sub-cortical structures are accompanied by subjective expressions in consciousness, can only be given when we have eliminated the cortex in its *entirety* from its sub-structures. The further relations that consciousness bears to the evolution of the special sensory structures will engage our attention later, and we hope to be able to unravel some of the numerous schemes which, hitherto, have served for theoretic purposes.

We have in Hughlings-Jackson's three-level scheme (1) a level for representations, (2) a level for re-representations, and (3) another for re-re-representations. Unfortunately, we are unable to associate these psychologically-expressed events with any definite brain-regions or structures. Were the præfrontal lobes the physical substrata for the reception of re-re-representations, these lobes would be essential for the proper correlation of modes of matter to modes of mind. We have no proof, however, that any part of the human cortex is indispensable to the manifestations of subjectivity. The contents of consciousness—previously acquired, and serving as the mental data upon which the ego preserves its continuity—may be rendered temporarily inert by interference with the modes of matter concerned with local memories (*e.g.*, word-deafness, etc.), but this is all. No amount of philosophy or argument will explain the evolution of a subject from an object. Neither will it prove the nature of that subject by the demonstration of the sources from which it receives its objective supplies, or data in consciousness.

We have, therefore, ample experimental and pathological evidences, that the mind can see, feel, and will, in spite of physical and structural discontinuities of the brain-cortex. Destruction of any brain-areas is, so far as our knowledge goes at present, not necessarily attended by alteration in the subjectivity of the mind. We may destroy, extirpate, or sever the connections of any of the cortical areas, and we can thereby cut off present supplies, or even render the results of former activities inert (memory); beyond this, however, we cannot go.

There is no way of evading the difficulty of adapting the subjectivity of the mind to anatomico-physiological data. When we advance in our knowledge of the data of consciousness (which are much the same now as they ever were), and the relations of the various structures of the brain, we may be able to formulate some more definite doctrines as to cerebral localisation. In the meantime, however, we can offer no ultimate solution of the one great difficulty. If we localise determinate activities within restricted areas, we become responsible for an account of some supreme site, where the mental correlates of these activities are viewed by the subject. Or if, on the other hand, we are indifferentists, we find ourselves confronted with the problem, of having to account for the mode by which the subject obtains its view of the objects correlated with physiological activities in widely-apart localities. It is needless to say, that whichever view we take, our difficulty will be in reaching the truth, so far as the subjectivity is concerned.

The answer of cerebral anatomy and physiology to the question of localisation of consciousness has, therefore, been of little value hitherto, and we are as yet unable to account for the phenomena of mind by the study of material structures. The mere fact that the formerly experienced contents of consciousness are rendered inert or incapable of being revived (as in cases of word-blindness and word-deafness, etc.) proves nothing, inasmuch as we are unable to prove, whether the contents themselves are destroyed or only rendered inert through lesions of the tracts, through which their causal or effectual activities have been or should be transmitted.

Before leaving this subject, it is necessary that we should review some of the more difficult problems which would stand in our way, even though we were able to localise a mental state as inhabiting a definite or restricted area, or as correlated to a generally-diffused activity.

Let us take, for example, the conclusion of one experimental investigator, that sensitiveness is the only specific energy common to ganglion-cells; and the inference drawn therefrom, that sensation is, in some way or other, the outcome or accompaniment of such a specific energy. Meynert and Munk both believe that—in order to explain conscious movement (*volition*)—it is sufficient to postulate sensations of innervation. Munk says, "Intelligence is located everywhere in the cerebral cortex, and nowhere in particular," and Meynert corroborates this view by adding, that Memory is the common property of all cortical cells and fibres which are able to receive and conduct external stimuli of all sorts.

We know that stimulation of the afferent nerve-tracts between the end organs of sense and the brain, in some way or another gives rise to sensations; similarly, influences acting centrally, such as drugs, gases, disease, or altered states of blood-supply, may determine activities with which sensations are correlated quite apart from the existence of the end organs of sense. So far as we know, all the modes of exciting the specific energy of the nerve-substance are reducible to modes of physical motion within that nerve-substance. In dealing with the activities of the material structures of the brain, therefore, any doctrines we may formulate are, of necessity, based upon the physical laws of gravitation, cohesion, chemical affinity, etc.

But no matter how ingenious the arguments, we can neither comprehend nor even imagine how the movements of atoms are associated with the phenomena of consciousness. It is just as impossible for us to determine the relations in space of the mind to the molecules of the brain, as it is for us to determine the area or areas in which the data of consciousness are presented to the *ego*.

The weighty and philosophical arguments of Hughlings-Jackson, that, from an evolutionary standpoint, each and every part of the body must be represented in any one unit of the cerebral cortex, are well worth consideration. In accepting this possibility we cannot, however, confine our attention only to that unit's *modus operandi* of representation. Such a representation on the part of the unit must also suggest to our minds its corresponding representation in consciousness.

The phenomena, which may be regarded as the attributes of the cerebro-spinal units, are embraced under Waller's scheme of the four R's—Reflection, Resistance, Radiation, Retention—and Summation.*

For present purposes, we need only concern ourselves with the modes whereby any of the four R's become correlated to sensation. The word "motion," in its broad sense, suggests itself to us as the executive operation which is correlated with the events of consciousness. The ultimate activity of that motion, so far as we can understand it, is intra-bodily, and seen in the working of the elements or units of the cerebral cortex. The unit, predisposed by its inherent and fundamental capabilities, would require the motion to be specific—*i.e.*, the mere dynamical operation of force irrespective of specific quantification is not sufficient to determine consciousness. The agitations set up must be of a certain fixed quantity. The rapidities, sizes, and directions of the movements must be specific, not only for each sense, but also for every modification of the activity each organ conditions. The vibrations must be horizontal in some sense-organs, in others perpendicular. The rapidity of the vibrations varies greatly even in different fibres of the same sense-organ. No matter how much we discuss the intra-quantifications of motion, we are forced to confess that

* (1) *Reflection.*—It is conceivable that every central element is an organ of return of action. It is excitable—exciting. (2) *Resistance.*—It is conceivable that each central element has a specific capacity for centrifugal tension resultant from centripetal impressions. (3) *Radiation.*—It is conceivable that centripetal impulses to a central element radiate to connected elements. Inferior impressions influence superior centres; in accordance with degree of resistance and strength of impulse. (4) *Retention.*—It is conceivable that after each period of activity and restoration there remains an altered constitution of central elements, in which resistance to homogeneous activity is diminished, to heterogeneous activity increased. (5) *Summation* (*and Inhibition*).—It is conceivable that two or more impulses summating in centrifugal tension or expression may be individually "friendly" or "unfriendly" to one another.

they are ineffective for the conditioning of human consciousness; in fact, such forms of movement are antagonistic to those particular quantifications or specific movements with which consciousness is correlated.

The activity of our sense-organs is undoubtedly determined originally by cosmical operative motions outside the body; but, although these outer motions may tend to influence our physical organisation, they have to be translated, changed, or modified, esoneurally, before they can determine our consciousness. To quote from Cyples, "What man may be said to be sensorially in contact with is his body; not the great physical world intellectually inferred as existing outside his body. With that larger sphere of the executive system he has, in fact, nothing to do sensorially; his sense-experience refers only to a set of dwarfed, retarded events, in some way answerable to the larger, swifter ones. There can be no doubt of this. Light, sound, heat, etc., in our sensible experience of them, are not born forthwith from the agitations of the interstellar ether science tells us of—they connect with the far more modest vibrations of the intra-bodily nervous substance as the latter takes on the former agitations at the peripheral limits of the respective sense-organs; or rather, we should say, as those peripherally-taken-on movements are delivered interiorly at what may be called the other terminals of the nervous system. In practice, that difference—if there be any—cannot be reckoned, and, by an intellectual calculation, the same in kind as those which ascertain the greater velocities, finer dimensions, etc., of the extra-bodily cosmical operations, it is now estimated that the transmissions in the nervous substance may be roughly set down at ninety feet per second. The enormous disparity between these figures and those calculated for the interstellar propagations need not be dwelt on." Of the numerous modes of motion to which science has given the names of gravitation, heat, electricity, chemical affinity, etc., the quantity of force is a fixed sum, and even though the ideal limits of science were reached, and the statical and dynamical relations supposed to connect the cosmical activities with organic operations were estimated, we should still be without the slightest explanation of how the physical organisation inherently develops the *specific* forms of motion upon which our consciousness is superimposed. By the study of anatomy and physiology, we gain our knowledge of an apparatus which is possessed of certain statical and dynamical relations, and we may further regard such an apparatus as being necessary for *specific* dynamical relations for the occurrence of consciousness—that is to say, we have to deal with three factors of extreme difficulty. Firstly, we must comprehend, in detail, the structures which form a basis for the statical and dynamical activities; secondly, we must determine the specific rapidities, directions, etc., of motion, which, although not immediately determining consciousness, form the functional activities of our nervous organism; and, lastly, we must determine, over and above mere statical relations, the fundamental and specific mode of motion, if any, which is directly associated with consciousness.

The so-called materialists concern themselves with the structure and systematised movements of the organism, and account for the facts of experience in consciousness as being the results of some specific and determinate relations; while the anti-materialists uphold the view that modern scientists assume, mistakenly, that organisation has some magic, accounting for the other facts of experience besides the occurrence of its own determinate movements and relations.

Mercier has forcibly drawn attention to the fact, that any attempt at a minute or detailed explanation of the physiological determinate conditions of consciousness will only result in "nonsense." He says:—"A process of change in the nervous system cannot cause a change of consciousness; such an effect is unthinkable. Nor can a change in consciousness cause a change in the arrangement of the molecules of the grey matter; such an effect is equally unthinkable." We agree that such causal relations are unthinkable; but we do not, at the same time, go so far as to negative their possibility merely because we do not understand them.

The prediction of Ladd,* that some of the most widely accepted of the physical formulæ are destined to be thoroughly shaken up in the not-far-away future, can never be fulfilled, because (1) no physical formula is conceivable; (2) no data are

* Presidential Address, "Psych. Rev.," vol. i. p. 2.

afforded to us for the construction of such a formula; and (3) even though science should reach its ideal limits, and furnish us with such data, the construction of a formula would, and could, only result, in its conception by us, as a formula pertaining to the domain of physics. Mercier says, that the student, when he has fully grasped the significance of the two notions—the "absolute separateness of mind and matter," and the "invariable concomitance of a mental change with a bodily change"—will enter on the study of psychology with half his difficulties already surmounted. The other half of the student's difficulties, we presume, will afterwards be found in elucidating the facts upon which the "invariable concomitance" theory is founded. Our conception of the inter-happenings of mental and physical activities is at present so vague that our powers must be devoted to their consideration, and without taking regard to any conception which extends beyond our scope of inquiry. Science acknowledges as its most powerful helpmate the imagination, and we are often forced to rest content with probabilities. Here, however, our part is merely to demonstrate the concomitance of the mental and the bodily events.

CHAPTER V.

Mind.

Scope and Methods of Study—Total Resources at our command for the Study of Mind—Subjective Methods—Subject-Consciousness and Object-Consciousness—The Objective Method—Logical Methods—Inductive Method—Deductive Method—Evolution Theories—Biological—Psychological—Presentationism—Mind-Stuff Theories—Atomistic Hylozoism—Parallelism—Psychological Import of the Theory of Self-Compounding of Mental Facts—Unconscious Cerebration—Arguments for and against the Theory.

Scope and Method of Study.—We have arrived at the simple conclusion, that the outer world of objects, and the physical executive nervous organism, are essential to the manifestation of our inner states of consciousness. Hitherto we have concerned ourselves with the possibilities of a more complete explanation of the workings of that physical organism, and we have fully appreciated the absolute dissimilarity of the phenomena of mind and matter. As Mercier says, "each is a separate world—a universe by itself," and we are unable to reduce the workings of the two series to common or convertible terms. Our attention will now be given to the study of the human mind.

The total resources at our command for obtaining an insight into the nature of mind are as follows* :—

1. Subjective observation and analysis.
2. Artificial experimentation, chiefly by employing definite external stimuli, the subjective effects of which are objectively noted and registered.

* Coupland, "Tuke's Dict. Psych. Med.," p. 31.

3. Pathology, or a study of bodily diseases, with their mental correlations.
4. The study of the growth of mind:—
   (*a*) By comparing mental development with the evolution of the nervous structures throughout the animal kingdom;
   (*b*) By study of the manifestations of mentality in the progress of mankind from a condition of barbarism to present civilisation;
   (*c*) By examining the development of the individual mind in the higher races of to-day.

To enter upon a question so large as that of the theory of our mental life, together with reference to the ultimate grounds of knowledge, would be out of place here. We can only take account of the various mental manifestations, and endeavour to describe or explain them with a view to the demonstration that they are in some way correlated to nervous processes.* For the present, however, just as the physiologist is able to take up the study of his object matter in its one-sided physical aspect, so we propose briefly to glance at the study of mind in its psychical aspect, not indeed as being *independent* of a physical basis, but as possessing properties which cannot be classed or explained under physical laws.

The **subjective methods** of study are open to this objection, that, no matter how much we study ourselves, the knowledge of our own individuality will be of little use unless combined with the knowledge of the individuality of others. Introspection is also necessarily retrospection, for the mind can only reflect, and cannot view its own states at the actual time of their occurrence; or, as Comte puts it, "the thinking individual cannot divide himself in two, of which one reflects, while the other sees it reflect." In order, therefore, to obtain facts of any importance, sources of personal error must be

* Although the terms "physical process," "nervous process," etc., are employed throughout, they are not to be regarded as explanatory in themselves, or as indicating a known quantity or quality; they merely imply the existence of functional activity within the physical executive mechanism.

corrected by a comparison of the results of self-observation in a number of individuals.*

Of late years the terms "*subject-consciousness*" and "*object-consciousness*" have crept into text-books upon insanity, and they are accepted as being self-explanatory. They serve a purpose, inasmuch as they denote, respectively, introspection, the taking cognisance of the mind's own states subjectively; and, the mental state which takes account of objects external to the individual. In accepting these terms, however, we must not overlook the fact, that our physical organism is just as much objective to consciousness as other external facts; and, further, that all the contents of consciousness are in reality objects viewed subjectively, so that the contents of consciousness itself are objective to the self or *ego*.

Another objection to the introspective method of study, to which allusion was omitted, is the circumstance that recent psychical states may furnish us with fairly-accurate data, but that when we attempt to deal with remote events, we are exposed to all the errors incident to memory. This, however, need not form a hopeless barrier to our gaining a fairly-accurate knowledge; and, as before mentioned, we can render this knowledge more accurate by a comparison of the results obtained by different individuals in order to eliminate the personal error.

The **objective method,** whereby we study the mind by means of its external effects, is indispensable to us, especially when we are dealing with its morbid manifestations in the insane. In pathological mental conditions, the

* The mind, apart from its physical correlations, may be said to supply a basis for many sciences.† (*a*) Psychology, as a whole, supplies the basis of education, or the practical science which aims at cultivating the mind on the side of knowing, feeling, and willing alike. (*b*) In its special branches, psychology supplies a basis to the following practical sciences:—*Psychology of Knowing.*—Logic, or the regulation of reasoning processes, together with the allied arts, rhetoric, or the art of persuasion, and that of forming opinion. *Psychology of Feeling.*—Æsthetics, or the regulation of feeling according to certain rules or principles—to wit, the admirable, or beautiful. *Psychology of Willing.*—Ethics, or the determination of the ends of action and the regulation of conduct by principles of right and wrong, together with the allied arts or sciences of politics and legislation.

† Sully, "Outlines of Psychology", p. 15.

psychologist has an opportunity of observing the phenomena of mind in varying and unusual combinations, and, as we shall see later, this helps us to confirm the theory of evolution by exhibiting the reverse order of mental dissolution.

The **logical methods** of studying psychology are also of manifest importance. If we are to argue correctly, and place this science on its right basis. we cannot afford to dispense with logic. We must have a science based upon proof and evidence, and not a science of belief. "Logic," says Mill, "is, to use the words of Bacon, the *ars artium*—the science of science itself. All science consists of data, and conclusions from these data; of proofs, and what they prove. Now, logic points out what relations must subsist between data and whatever can be concluded from them; between proof and anything which it can prove." No doubt there are many gifted men in our profession who are able to dispense with the recognised *formulæ* of logical and inductive science. They may possess a natural aptitude or intuitive perception of the principles of logic, and furnish us with recondite principles, or ready generalisations, without a knowledge of the elements of the syllogism. Unfortunately, however, in the study of psychology, perhaps more than in that of any other science, having to unravel the mysterious phenomena of mind, and investigate the deviations from its normal state, we are peculiarly exposed to many sources of fallacy unless guided by the principles of the inductive process of reasoning. A knowledge of principles and conclusions can usually only be reached by a succession of steps, after the result of much labour and long-continued reasoning; and we cannot hope to arrive *per saltum* at sound philosophical doctrines except by such logical and laborious methods of study. The domain of mental physiology has been particularly seductive to those who would cultivate it as a science; and the foundation of much of the bad philosophy, with which we are met on all sides, is due to the illogical method of deducing general principles from the consideration of a few particulars. Exner* says, "A product cannot be thoroughly comprehended before its factors." Otherwise, we are apt to form hypotheses which are, of necessity, based upon premature and unsatisfactory data.

* "Kritik der Hegelschen Psychologie," Leipzig, 1842.

The golden rules of Descartes, as set forth in his discourse on method, might with great advantage commend themselves to many of the workers of the present day.* Our object, therefore should be, not to form doctrines based upon immature considerations, but to study the workings of our physical organism down to the minutest detail, and, as psychologists, to investigate the phenomena of mind, and then, when we have exhausted the materials at our disposal, to see how far the data resolve themselves into premises for a syllogism. A rational view is all-important, and such a view of all the facts of mental physiology will more than confirm the words of Coupland, that "physiologists and subjectivists cannot come to terms by merely flinging down their contributions side by side." Of the logical methods of studying psychology we have, (1) the *inductive* method, or analysis, as pursued in self observation. The observer starts with a highly-complex psychical state; and (2) the *deductive* method, or synthesis, corresponding to the objective method, in which, by synthesis, elementary facts are reconstructed by successive stages.

The methods of studying the mind by experimentation will be discussed somewhat in detail when we consider the quantitative relations of physical and pyschical phenomena, and among the problems we shall have to determine are, (1) the limit, threshold, or liminal intensity of stimulation; (2) the extent of nervous agitation, or excitation requisite for a mental phenomenon; (3) the duration of the central nervous process implied in mental phenomena; and (4) variations in the quantity of nervous action and of mental phenomena, and the relation of the one to the other. Since Fechner first demonstrated, with a certain amount of success, that some psycho-physical relations

* (1) Never to accept anything as true, which we do not clearly know to be so—that is to say, carefully to avoid haste or prejudice, and to comprise nothing more in our judgments than what presents itself so clearly and distinctly to the mind, that we cannot have any room to doubt it. (2) To divide each difficulty we examine into as many parts as possible, or as may be required for resolving it. (3) To conduct our thoughts in an orderly manner, commencing with the most simple and easily known objects, in order to ascend by degrees to the knowledge of the most complex. (4) To make in every case enumerations so complete and reviews so wide that we may be sure of omitting nothing.—*Veitch's Translation, Edinburgh*, 1850.

were capable of exact mathematical statement, a vast number of important propositions have accumulated. Such experimentation, as carried on either in laboratories or in asylums, has been rewarded in some instances by unlooked-for results. But, as Coupland says, "an individualistic psychology, aided by all the resources of the physical laboratory or clinical experience, would be but a maimed and incomplete psychology."

The study of mental life in the lower animals, and the comparison of elementary psychical phenomena, must, of necessity, be objective; but it is none the less valuable, because the manifestations of psychical action can be studied by many, and the risk of errors in observation corrected.

Evolution.—When we face the strong position held by the theory of *biological* evolution, we have a multitude of evidences in its favour, so long as we concentrate our arguments upon the problems which have to do with animate existence; but when we proceed to include the higher problems pertaining to thought, we encounter, at the very outset, an almost insurmountable difficulty. If we agree with Bain, that nothing is held to be innate that can be shown to arise from experience and education,* we must, of necessity, trace all forms of thought to experience conditioned by our sensori-motor nervous mechanism; and, as we are led to assume that sensation is the starting point in consciousness of our more complex states of mind, a *psychological* theory of evolution becomes responsible for a scientific account of the genesis of all the intellectual powers. In a theory of evolution, our complex states of consciousness must be regarded merely as developments, under natural law, from our simplest state. Unfortunately, as Mill says, "we have it not in our power to ascertain by any direct process, what consciousness told us at the time when its revelations were in their pristine purity. It only offers itself to our inspection as it exists now, when those original revelations are overlaid and buried under a mountainous heap of acquired notions and perceptions."† A theory of biological evolution would have to start with the organism

* "Mental and Moral Science," B. 2, C. 6.

† Mill, "Examination of Hamilton's Philosophy," p. 171.

and its functions, and afterwards seek to demonstrate the development of the higher mental functions from the data given. Such an attempt would, however, soon result in the conviction, that states of consciousness must also be accepted as data given. The view that the organism is the product of heredity, under laws operating through long ages, and that mind is the manifestation of functions belonging to the most advanced organism, would be the *pure* theory of evolution. This type would secure unity, but its support would involve us in greatest difficulties.* A *mixed theory* would take account of the mind as independent or superadded life, making sensation the origin of all knowledge, and subjective protoplasm that from which the mind, in its higher manifestations, is gradually evolved.

Of the biological theory, Darwin and Wallace have been the leading advocates, whilst the psychological has been supported mainly by Mill, Bain, Spencer, and others. A third theory—the theory of dialectic evolution—is elaborated in the philosophy of Hegel. According to this form of philosophy, four presuppositions are involved—viz., (1) *existence*, in order that there may be a philosophy of it; (2) *personal existence*, as distinct from existence external to itself—from nature, as apart from the thinker; (3) *experience in consciousness*, as affording knowledge of both; and (4) the *conditions of thought* given in the nature of our intelligence.†

Of these three theories we have to concern ourselves with the psychological; and the problem resolves itself into the question, Is sensation the germ of all that belongs to mental life? and can we account for all intellectual action by evolution from sensation? James Mill says, the order of occurrence is this, contact, excitation of apparatus, sensation. The spheres of occurrence are: the external world, the organism, consciousness. Thereby is implied, that the simplest fact in experience is consciousness of sensation. It suffices us to concern ourselves with the primary fact—a given experience—out of which an hypothesis of evolution is to be constructed. Now we naturally ask, Granted that sensation is consequent

* Calderwood, "Moral Philosophy," p. 97.

† Calderwood, ibid., p. 132.

upon excitation of a sensory nerve, is intelligence a prerequisite for sensation? or, adopting the formula of Waller. Granted that sensations afford the data ("*major*," or "*minor*" premises) for the construction of a syllogism, do the data themselves compound and evolve an intelligent conclusion? or, does the intelligence construct a conclusion from the data presented to it? If the former is possible, then the advance of the sensational theory is ensured. If not, the evolutionist finds some difficulty in extricating himself from a conclusion that is manifestly absurd. Consciousness not only presupposes sensation as derived from a sensory apparatus, but it also implies personality—that is to say, consciousness is knowledge of personal existence. It is self-consciousness. There is knowledge of the object sensation, in contrast with subject self. The notion of self as a consequence of memory. does not negative the presupposition, that intelligence existed synonymously with sensation. Mill* says, "There is no meaning in the word *ego* or I, unless the I of to-day is also the I of yesterday." A conception of our personality is something much wider than knowledge of self as intelligence. It gathers up into a single representation the several characteristics of our intelligence as these are brought to unity in life. If a being can appear anyhow to itself, it must be capable of unifying manifold phenomena in an absolute indivisibility of its nature.†

Münsterberg‡ views all mental states, emotions, and volitions, as well as cognitive states, as being simply complexes of sensations. This view has often been severely criticised, and it has been called intellectualism, inasmuch as it ignores any elements other than are cognitive.§ Ward|| calls this the theory of "*presentationism*." It may be used in a narrow or in a broad sense. In its narrow sense it is the doctrine that all the mental states may be resolved into sensations, and this is the sense in which Wundt condemns it; whilst

* "Analysis," 2nd edit., i., 229.

† Lotze's "Microcosmus," Tr. i., 157. Kant's "Transcendental Unity of Apperception."

‡ "Die Willenshandling," 1888.

§ Wundt, "Philos. Studien." vi. 3, 1890, pp. 387, 388.

|| "Modern Psychology."—"Mind," Jan., 1893.

in its broad sense, it means that consciousness has only to do with conscious events.

The narrow sense, that all the elements of psychical life are primarily and ultimately cognitive elements, is, to us, inconceivable; whereas, the broad sense, that all the elements of psychical life are facts of conscious experience, and that psychology has to do solely with conscious processes and events, admits of feelings and attention, and also of the existence of a self which has these feelings and exerts this attention as distinct from sensations and ideas; *i.e.*, it holds that the feelings, the attention, and the self, are facts of conscious experience. The very existence of such conditions as feelings, ideas, and self, consists in their being facts of conscious experience; if there were not such facts, we should never know anything about them.* Ward summarises the whole account of the subject in an introspective observation, and three inferences.

The facts of mind cannot be properly expressed by saying, there are feelings, ideas, volitions, but only by saying, I have feelings; I have ideas; I have volitions; or, I feel, I know, I will—*i.e.*, every mental state involves a subject by whom it is known, felt, or willed.

Inferences.—(1) A subject must be conceived as distinct from the state which it knows, or feels, or wills; (2) it must be conceived as different in kind from all ideas or feelings, or possibilities of such; and, (3) since all knowledge implies a subject which knows, all feeling a subject which feels, it follows that this subject, just because it is the subject, cannot itself be directly known or felt. That sensations are essential to consciousness is evident, but to argue that they are essential to the development of consciousness, and are thus the primary factors in the evolution of intelligence, is as forcible as to argue, that nutriment, which is essential to us, and to our physical development, is the primary factor through which we are to trace the biological evolution of our organism.

And now let us see what the theory of evolution, as it now stands, has to say upon such a question as memory. We may grant that the sensitive organism transmits, in some

* Münsterberg, "Psych. Review," vol. i.

way or another, a series of activities which ultimately manifest themselves as the physiological equivalents or correlates of sensations; but we have still to explain how these different sensations could form an aggregate which would correspond to intelligence. Does the one sensation, by a force of attraction, cohesion, or gravitation, appose itself to a like sensation? or does the one compare itself with the other, and, by an inherent power, relegate itself to its proper spheres? Could we conceive the millions of letters received into St. Martin's le Grand daily sorting themselves into their respective departments without the intervention of an intellectual guidance. Or, again, do the numbers of facts and observations at our disposal arrange themselves as data in a logical sequence, the result of which is our conception of their arrangement and import? A sensational theory would have to prove. that succession, relation, and difference are not matters of knowledge; and those who uphold the view must show how observation, comparison, and memory can be originated. Were we to grant that one sensation possessed the power of comparing itself with another, it is evident that, in order to do so, one sensation would possess at least the power of distinction between subject and object; and here would be acknowledged an intelligence pertaining to the sensation itself.

"According to evolution," says Professor Calderwood, "they are all to be created by advance from lower to higher, yet without these higher we cannot have experience. Without observation, involving at least the distinction of subject and object, there can be no such memory as we rely upon in building up our knowledge; without memory there can be no thought; without thought no rational life. Neither from organism nor from sensation can help be found here. No series of sensory impressions will produce thought; no series of sensations can result in anything higher than its own content."

Cyples says, "Very early we learn that these diversifications of experience, as well as the startings and stoppings of consciousness generally, are determined not by ourselves—at least, not in their natural, unartificially-produced happenings. They are somehow imposed and prescribed. Moreover, the intellect, by its own proper function, comes to apprehend that a certain order discloses itself in these occurrences, one event following upon or grouping with another. The intellect's complete task is, from these data, to formulate working-rules which will explicate the arising and the ceasing of our consciousness, with the occurring of the diversifications of experience into kinds while it subsists."

The failure to appreciate how unintelligible is the sensational theory of evolution may be attributed to the fact, that some writers direct their efforts more in the direction of giving an explanation of the fundamental nature of the manifestations, than of trying to observe the manifestations as they occur. To us it is all-important to accept no assumptions as valid unless they are quite intelligible. Otherwise, we raise for ourselves barriers which arrest our progress and involve us in endless difficulties. From all points of view the evidence in favour of the theory of sensationalism is in direct opposition to our common sense, and we say of it, as it now stands, the evolution of a cognitive state from a sensation without the existence of an intellectual guiding factor or personality as a pre-requisite, is as readily conceivable as the evolution of a sporran from the classical fig-leaf without the intervention of a tailor.

The assumption that our mental states are composite—*i.e.*, made up of smaller states conjoined—has been termed the "mind-stuff" theory, and its consideration has engaged the attention of many psychologists. If we are to be thorough in our scheme of the evolution of mind, we must either account for the introduction of mental factors, at some period in the history of the organisation of the original cosmical chaos, or we must surrender that position, and grant the existence of mind from the beginning. That is to say, we must either be materialists, or accept as a fundamental truth the twin evolution of mind and matter. To enter into the metaphysical questions involved in any attempt to introduce mental factors among the chaotically-dispersed atoms of the universe, is obviously beyond our scope of inquiry. We have merely to note the undeniable discontinuity of the data, and the failure of evolutionists to provide us with explanations upon these points.

The advocates of true parallelism must, of necessity, be the enemies of evolutionists; and, to use a paradox, the strength of the chain of evidence of the former is made up of the missing links of the latter. It is pathetic to note the positive affirmations of some writers, that there is no possible or conceivable causal connection between mind and matter; and yet they are foremost in giving the body priority as a causal factor in the introduction of mind. "When the evolutionary afflatus is upon them," says Professor James, "these very same writers leap over the breach, whose flagrancy they are the foremost to announce, and they talk as if the mind grew out of the body in a continuous way."

Spencer* attempts to demonstrate how we pass "*without break* from the phenomena of bodily life to the phenomena of mental life." His conception, that the truth of life is the "continuous adjustment of internal to external relations," is manifest to every one; but we fail to observe, either *how* we pass from physical to psychical actions, or the moment *when* we rise above the correspondences that are few, simple, and immediate. "On ascending from the lowest types of life," says Spencer, "one marked manifestation of the heightening correspondence is the increasing distance at which co-existences and sequences in the environment produce adapted changes in the organism. This progress accompanies the development of the senses of smell, sight, hearing, etc., and the subsequent development of the intellect."† His assumption—that all forms of sensibility to external stimuli, are, in their nascent shapes, nothing but the modifications which those stimuli produce in that "duplex process of integration and disintegration, which constitutes the primordial life, physiologically-considered"—is, to say the least, vague and confusing.‡ To speak of *forms* of sensibility as modifications produced by stimuli would appear to be warrantable; but no argument would warrant the conclusion that the external stimuli determined the sensibility itself. It is manifestly true, that various stimuli determine modifications of the organism upon which they act; but they

* "Psychology," § 131.

† Op. cit., § 139.

‡ To the theory that forms of sensibility to external stimuli are in their "nascent" state, James takes serious objection. He points out, that merely to call the consciousness nascent will not serve our turn. He says, "It is true that the word signifies not yet *quite* born, and so seems to form a sort of bridge between existence and nonentity. The fact is that discontinuity comes in if a new nature comes in at all."

do not determine the existence of that organism. Were such arguments possible, our difficulties in accepting the evolution theories would be smoothed over.

The theory of *atomistic hylozoism* seems to be the most philosophical view of evolution, and, according to its advocates, there must have been an infinite number of degrees of consciousness following the degrees of complication and aggregation of the primordial mind-dust. Here, however, we are treading upon metaphysical ground, so we return to the psychological significance of the mind-dust theories.

Spencer concludes, that the progress of the correspondence between the organism and its environment necessitates a gradual reduction of the sensorial changes to a succession; and by so doing *evolves a distinct consciousness*—a consciousness that becomes higher as the succession becomes more rapid and the correspondence more complete.* The question naturally arises, At what period of the succession of sensorial changes is a distinct consciousness evolved? Spencer † denies that he means by this passage to tell us anything about the origin of consciousness at all.‡

In a succession of sensorial changes (psychologically-considered), did consciousness evolve with the first, second, or hundredth sensation in that series? If with the second, the first would have no place in it; if with the hundredth, the previous ninety-nine would have no place, because they could only exist so far as they were manifested in consciousness. To say that the factors in the succession become more complex as they advance, does not simplify matters. The question becomes (1) did the primordial bioplasm answer to its first stimulus from without, or did it wait for a period when the stimuli had so modified it that it was then able to respond and manifest itself as life? (2) did the first stimulus entail even the most rudimentary form of sensation appreciable by the bioplasm? or, (3) did the organism appreciate the stimulation only when

* "Psychology," § 179.

† "Fortnightly Review," vol. xiv. p. 716.

‡ "This resembles," says Professor James, "too many other passages in his 'Psychology' not to be taken as a serious attempt to explain how consciousness must at a certain point be evolved."

previous stimuli had advanced the evolution of its complex adaptive apparatus? If the human mind is to be evolved from mere complexity of physiological arrangements, then why not also evolve vitality from mere complexity of mechanical forces? The conclusion of the sensationists is, obviously, that our knowledge arises from the evolution of data unknown to us.

Can we arrive at an idea, conclusion, inference, or whatsoever it may be called, only at some period in the evolution of a succession of data, taking no account of data which occurred earlier in that series? Consciousness must start somewhere within that series, and its evolution must depend upon initial sensory change *plus* subsequent sensory changes. The contents of consciousness at any period in that succession must involve the pre-existence of antecedent states right to the very origin of that consciousness. Hence, we again find ourselves compelled to beat consciousness back to the beginning of sentient existence. In fact, the theory that holds consciousness to be dependent upon the arrival at a period, when the correspondence of the mechanism to its environment is more elaborate and complete, conveys as much meaning, concerning the origin of intelligence, as do the activities of a lamp-lighter concerning the origin of light.

Spencer says that the doctrine of evolution, under its purely scientific form, does not involve materialism, though its opponents persistently present it as doing so. He also speaks of the materialistic hypothesis as being "utterly futile." Hughlings-Jackson says, that to describe Spencer, Huxley, and Tyndall as materialists is as absurd as to speak of Sir Joseph Lister as an opponent of antiseptic surgery. The words of Spencer—"No effort enables us to assimilate mind and motion; I am merely showing a *parallelism* between a certain physical evolution and the correlative psychical evolution"—would apparently place him above any effort to assimilate mind and matter, or any attempt to show that material actions thus become mental actions. But, again, we ask, If a parallelism between a certain physical evolution, and the correlative psychical evolution has taken place, was that parallelism complete? or was a certain degree of physical evolutionary complexity essential before the psychical parallel could be started at all?

The "happening" of consciousness thus becomes a problem of the "first cause," and the psychical functions must have existed coincidentally to the beginnings of life. Any attempt to posit the dawn of consciousness coincidentally to a more complexly-developed state of the physical organism is neither true evolution nor parallelism, it is materialism, and seeks to account for the origin of one series of events by taking account of the total complex of the other series. If the two series of events are to correspond they must go hand in hand from the beginning. They must be twins—the one must not be born, and the other happen later on. If there is to be a period of nascence with the one, so there must also be with the other. As far as we can see, the nascence of the one must evolve into perceptible life; that of the other into conscious experience. The one is not born from a rib of the fully developed other.

One contention of the spiritualists against the associationists in psychology—that individual minds do not agglomerate into a higher compound mind—has never been answered by the latter. With this contention we have little to do. Our object, however, includes some discussion of the theory that mind-dust exists, and that mental objects can be compounded.* The self-compounding of mental facts is quite inadmissible. In favour of this view Professor James has pointed out in very clear language, that at most we can compare together objects previously presented to us; but then we find each object stubbornly maintaining its separate identity before consciousness, whatever the verdict of the comparison may be. "All the combinations which we actually know are *effects*, wrought by the units said to be 'combined,' *upon some entity other than ourselves*." "In other words, no possible number of entities (call them as you like, whether forces, material particles, or mental elements) can sum *themselves* together; each remains, in the sum, what it always was; and the sum itself exists only *for a bystander* who happens to overlook the units, and to apprehend the sum as such; or else

* See Royce, "Mind," vi. p. 376; Lotze, "Microcosmus," Bk. ii., Ch. I., § 5; Mivart, "Nature and Thought," p. 98; Fechner, "Psychophysik," Bd. ii., Cap. XLV.; Brentano, "Psychologie," p. 209; Tyndall, "Fragments of Science," p. 420; Hughlings-Jackson, "Croonian Lectures," 1884.

it exists in the shape of some other *effect* on an entity external to the sum itself." The contention of the spiritualists holds good, says James, against any talk about self-compounding amongst feelings, against any "blending," or "complication," or "mental chemistry," or "psychic synthesis," which supposes a resultant consciousness to float off from the constituents *per se*, in the absence of a supernumerary principle of consciousness which they may effect. "The mind-stuff theory, in short, is unintelligible." The contentions of Ward* and James agree in their main points, and they rightly take objection to the views of "mind-stuffists," and associationists, that the "series of states" *is* the awareness of "itself"; that if the states be posited severally, their collective consciousness is *eo ipso* given; and that we need no further explanation or "evidence of the fact." If we try to imagine the ideas of the various constituents of a haggis positing themselves in our mind, side by side, so as to form a combination or resultant idea of the haggis in its entirety, that resultant idea would really consist of a reference to a haggis previously compounded and presented to us in its entirety, while the ideas of the constituents would remain more or less intact and separate.

The super-position of many photographs upon one another gives us a composite product more or less blurred or indistinct, and the mind becomes aware of the properties of that product as presented to it; but the mind cannot look at a series of pictures, and by placing their mental images side by side form a composite mental representation of them. The mind can only review the component parts of the series, and it can only view an external resultant combination.† Thus, it deals with the haggis. The taste of

* "Encyclopædia Britannica."

† "I find in my students," says James, "an almost invincible tendency to think that we can immediately perceive that feelings do combine. 'What!' they say, 'is not the taste of lemonade composed of that of lemon *plus* that of sugar?' This is taking the combining of objects for that of feelings. The physical lemonade contains both the lemon and the sugar, but its taste does not contain their tastes, for if there are any two things which are certainly *not* present in the taste of lemonade, those are the lemon-sour on the one hand and the sugar-sweet on the other. These tastes are absent utterly. The entirely new taste which is present *resembles*, it is true, both those tastes."

the compound may be recognised in its combination, or the *gourmet* may even succeed in the detection of elements which would baffle the majority. Let the uninitiated, however, separately imagine the taste of finely-chopped sheep's heart, liver, etc. etc., suet, and oatmeal; then let him conjure up a high seasoning of onions and pepper, and then let him sum up the sensation that would correspond to such a compound after it has been "boiled i' the maw." Even a Scot would confess to failure, and refer to the taste of the compound as formerly presented to him. Of the views of the associationists we shall have much to say in subsequent chapters, so that we now proceed to consider a question implied by the mind-stuff theory—viz., that states of mind may be unconscious.

Unconscious Cerebration.

The arguments for and against the theory are as follows*:—

For.	*Against.*
1. Below the point of liminal intensity of stimulation there must be a certain degree of cerebration, because only a small addition is necessary to produce an appreciable sensation.	Because three men are just able to lift a ton weight one foot, it does not follow that two men are able to lift it 8 inches.
2. The intelligence displayed in so-called automatic acts.	There may have been consciousness, but the memory of it absent.
3. Thinking of A, we presently find ourselves thinking of C. Now B is the natural logical link between A and C, but we have no consciousness of having thought of B. It must have been in our mind "unconsciously," and in that state affected the sequence of our ideas.	Either memory at fault, or B's brain tract alone was adequate to do the whole coupling of A with C, without arousing B.
4. Solving problems during sleep, somnambulism, awakening at a predetermined hour, unconscious thinking, volition, time registration, etc. Consciousness must have presided over these acts.	There may have been consciousness, but it is forgotten, as in the hypnotic trance.

* James, "Principles of Psychology"; Carpenter, "Mental Physiology," Chap. XIII.; Laycock, "Edin. Med. Journ.," July, 1838; Baldwin, "Handbook of Psychology," Chap. IV.; Wundt, "Ueber den Einfluss der Philosophie," Antrittsrede (1876), p. 10; Hack Tuke, "Unconscious Cerebration"—"Dictionary," p. 1336.

For.	*Against.*
5. The complicated processes performed in epileptiform unconsciousness (larvated epilepsy).	Rapid oblivescence, as in dreams, occurs.
6. Our conclusions often arrive quite unexpectedly without any attempt to analyse their premises. This pre-supposes a mass of ideas in an unconscious state.	No such mass of ideas is supposable. The predisposition to bring forth a conscious idea is no evidence that the idea existed unconsciously. Brain processes form the predisposition to call forth the idea, just as external physical processes form the predisposition to call forth the brain processes.
7. The general fitness of instinctive actions indicates unconscious intelligence, as the ends are not foreseen.	The actions may be explained physiologically as occurring along the lines of least resistance.
8. Rapid judgments of size, distance, shape, and the like, are ready-made conscious percepts derived by unconscious inference.	Results like those of reasoning may accrue without any actual reasoning process unconsciously taking place.
9. We constantly discover new elements in accustomed sensations. These elements must have existed in an unconscious state, otherwise we could not single out the sensations containing them from others nearly allied.	We may have an idea and subsequently know all sorts of things about it. That we *now* become aware of the attributes of an object formerly presented is no proof that the awareness of these attributes must have existed unconsciously.

That unconscious cerebration can go on, and does go on, without any obvious mental accompaniment is readily conceivable; but when it refers, not to cerebral activities, but more particularly to mental modifications, without the consciousness of the subject, we find ourselves in difficulties. Undoubtedly, many of the phenomena described as evidences of unconscious cerebration may be compared to the automatic unconscious movements of the limbs from habit, as, for instance, in playing the piano. Griesinger has termed it psychical reflex action. According to the associationists, the development of a single thought is effected by the functional activity of association bundles, which unite in a very complicated way the component elements of a so-called residual image of the cortex. These groups of associated cells, which harbour residual images, are the starting point for the excitation of more comprehensive associations, constituting simple processes of induction. In this way every process of thought originating from residual images would be connected with a large number of distinct cerebral elements, and it would have, as its physical counterpart, many separate and well-defined areas of excitation, which areas are united for common action by the process of association. Each area is regarded as a separate and fairly-well-defined group of ganglion-cells, standing in relation to one another through the complicated system of association fibres, and every cortical image or inference depends upon the union of these groups of cells. This view, as we have already seen, precludes the possibility of localising the excitation in the forebrain, and, according to Meynert, the projection system alone stands under the influence of the centres of excitation.

For illustration, let us compare the centres of excitation and the projection system to numerous stations on a complicated branching railway. Some associationists hold that the ideas gain their component parts from the separate stations. They imagine that the physical equivalents of these component parts travel either directly or indirectly from their several localities to the central terminus (consciousness) and emerge, not as separate events, but as one event—*i.e.*, the results of the separate events compounded *en route*. Consciousness, viewed as the central terminus, is not supposed to witness the arrival of individuals, it only witnesses a conglomerate mass of fused passengers. Such is the line of thought advocated by the mind-stuffists, associationists, and unconscious cerebrationists. They postulate that psychological data self-compound into conclusions.

Let us continue the analogy a little further. The official recorder of arrivals (ticket collector) at the terminus, on entering upon his duties, notes the individual arrivals with more or less interest. With the daily repetition of the numerous arrivals, however, his acts of checking become more and more automatic, and the individuality of each passenger less distinct, until finally he comes to view, not the individuality of any passenger, but the sum total or mass of individuals, with, perhaps, some faint qualifying attribute, such as "pushing," etc. In the course of his duties he one day experiences the feeling, that a certain face is familiar to him, but he cannot recall where or when he has seen it before. Or a particularly vigorous push by a passenger may make him become aware of the fact, that that same passenger had done the same thing on a former occasion. We might continue the simile, but we should find that every contingency would fit in with the possibility of the occurrences *within the realms of diffuse consciousness, and without the direct concentration of attention.* In other words, the realms of diffuse consciousness are so wide, that they include most of the phenomena regarded as evidences of unconscious cerebration. The mere fact, that there is inability to recall former conscious events, is insufficient proof that those former events never existed, or that they existed unconsciously. The theory of unconscious cerebration we, therefore, hold to be superfluous and unproved. In his lectures on metaphysics* Sir William Hamilton states, that the greater the number of objects among which the attention of the mind is distributed the feebler and less distinct will be its cognisance of each—*pluribus intentus, minor est ad singula sensus.* As we shall have occasion to speak more fully of these things when considering the phenomena of trance, somnambulism, hypnotism, and epilepsy, we will now sum up in general terms our present position with regard to the evolution of mental states.

From the affirmation of a universal law of evolution more information is derived than from the affirmation of particulars; it logically follows, that more information can be derived from the denial of particulars than from the denial of universals—*i.e., there are cases left doubtful.* That there are cases left doubtful requiring the proof or denial of particulars is manifest in current literature upon mental evolution. By the employment of terms such as "unconscious inference," "cortical trace," "subsidiary image," "nascent consciousness," as terms of propositions, we beg questions, and imply the existence of knowledge which we really have not got; and in

* Vol. i., p. 254.

the attempt to define that of which we know nothing we enter upon the fallacy of a *circulus in definiendo*. Thus, if the student will sift the terms employed in the various propositions put forward by the mind-stuffists and cerebralists he will readily detect the abuse and equivocation, brought about, no doubt, by their attempts to substitute terms, the definitions of which they neither restrict nor explain.

CHAPTER VI.

SENSATION.

Sensation—Analysis of Sensations and Sense Percepts—Relation of Sensations to Perception—Molar Motions—Atomic and Molecular Motions—Motions of Ether—The Theory of Electricity—Latent Chemical Energy—Power of Selection possessed by Sense Organs—Characters of Sensation—Intensity or Degree—Liminal Intensity—Forms of Excitation—Weber's Law—Discriminative Sensibility—Maximum Intensity—Fechner's Psycho-Physical Interpretation of Weber's Law—Wundt's Psychological Interpretation—The Physiological Interpretation—Validity of Weber's Law—The Estimation of Magnitudes by Comparison—Measurement of Absolute Mental Magnitudes Impossible—Quality of Sensations—Generic and Specific Quality—Duration—Local Characters of Sensations—Taste—Smell—Touch—Specific Functions of Tactile Corpuscles or End Bulbs—Pressure Spots—Temperature Sense—Common Sensation—Peripheral Reference of Sensations—Muscular Sense—Hearing—Sight—Pressure Phosphenes—Quality of Sensations of Sight—Simple and Mixed Colours—Colour-Blindness—Young—Helmholtz—Hering—Wundt—Von Kries—Franklin.

In the analysis of sensation and sense-percepts it is necessary (1) to distinguish simple sensations from those derivative and more complex psychic manifestations, to which our educated consciousness becomes so familiar, that it loses sight of their origin and integration; (2) to demonstrate the quantitative and qualitative variations of sensations and their relations to the various stimuli; (3) to investigate the psychical methods whereby our perceptions of time-form and space-form are arrived at; (4) to estimate the part played by the various senses, and to see how far the higher mental activities are involved in the processes of perception.

The term "sensation" is used to express the most elementary form of conscious experience. It is a mental state resulting from the stimulation of the peripheral extremity of a sensory nerve, through which the excitation reaches the sensorium. The senses provide our minds with supply. They fill up our consciousness with data from which we gain our ideas. All sensations appear to have some physical occasion. They do not necessarily involve the action of an external stimulus. When a sensory "incarrying" nerve is divided there is no sensation arising from external stimuli, but subjective sensations may still arise through the activity of a central process, the nature of which is unknown to us. In mental diseases such modes of activity within the sensorium are remarkably frequent.

Coupland* regards the term sensation as connoting a subjective condition which has no mental but only a physical occasion. He claims that a truly original mental phenomenon passes the limits of imagination, because it passes the boundaries of our knowledge. The phenomenon of sensibility may pertain to the organism, but the phenomenon of sensation pertains to the mind. All sensations are modes of behaviour of the mind. Sensations only exist in so far as they form contents of consciousness. They are not copies of outside molecular activities; they are modes of conscious activity of the mind. If we take an ordinary psychical activity, and seek to appose it to its material basis, we have to consider (1) the external stimulus, which is physical; (2) the excitation and transmission of the stimulus; and (3) the psychical process itself.

All our knowledge is obtained from objects presented in consciousness, and we cannot properly speak of knowledge where no object is presented. Sensations are the mental objects presented to the subject; they only exist when presented. This presentation of objects is the first clear act of consciousness. Sensations do not exist except in so far as they are perceived by the subject. Sensations are particularised when perceived, and this perception is the first mental fact. The first psychical element perceived by the mind is sensation; the first act of viewing that sensation is perception.

Thus sensation is the first presentation to the consciousness; perception is the first recognition of that presentation. Sensation is the stimulus within consciousness; perception is the

* "Tuke's Dict. of Psych. Med.," p. 32.

appreciation of that stimulus by the mind. What happens within the cerebral hemispheres immediately antecedent to what happens within consciousness is beyond our powers to determine. Ward* thinks a presentation (as presented to a subject) might, with advantage, be called an object, or perhaps a psychical object, to distinguish it from what are called objects apart from presentation.

In the meantime we shall treat of presentations in their literal sense, as presentations to the subject or *ego*. Each presentation has a twofold relation: (1) Its relation to the subject; and (2) its relation to other presentations. Ward states, that the mental facts which we speak of as sensations, perceptions, images, intentions, concepts, notions, etc., have two characteristics in common: (1) They admit of being more or less attended to; and (2) they can be reproduced and associated together. Thus the term *sensibility* would possess a psychical significance, and would denote the mind's capability of having sensations. *General sensibility* is that sensibility which represents all the sensitive parts of the organism other than the special sensory organs. Sensations of this character, involving no characteristic nervous structures, are vague and ill-defined. *Special sensibility* is the term employed to indicate the mind's sensibility to special sensations, brought about in most cases by external agents through the special senses, and from which we gain a knowledge of our environment.

One simple sensation rarely acts alone. All our senses are open to impressions from without, and our minds are constantly open to impressions from within the body; so that, just as the external environment is constantly taking effect upon our physical organism, so the physical organism is constantly taking effect upon our consciousness.

The *various kinds of motion* which can act upon the peripheral organs of sense are as follows:—

(1) *Molar motions:* the projection or impact of elastic or inelastic bodies. Definite motion is executed in a definite direction by a material body. To this class belong all the stimuli of touch and pressure.

(2) *Atomic* and *molecular motions:* Motions resulting in chemical changes within and among the molecules. Besides

* Encyclopædia Britannica, "Psychology."

the stimuli of taste and smell, many visceral stimuli also probably belong to this class.

(3) *The motions of ether:* The vibrations of ether, pervading the space between the molecules of matter, according to their velocity, produce the phenomena designated as "light" and "radiant heat," and probably, also, those of "magnetism" and "electricity."*

The forms of energy may exist as energies of *motion* or of *position*, and the actual constitution of the universe is due, in a great measure, to the alternation of these two energies. The various forms of active energy show themselves as (1) the energy of visible motion, which may be transformed into an equivalent amount of energy of position; (2) molecular energy, which causes the cohesive attraction, repulsion, and other proper motions of the minute and invisible particles of matter; (3) energy of heat and light, which are transmitted by waves of the assumed imponderable medium called ether; (4) energy of chemical action, by which the small ultimate particles of ponderable matter, called atoms, separate and combine into the various combinations of molecules constituting visible matter, in obedience to certain affinities or inherent attractions and repulsions; (5) electrical energy, which includes magnetism as a special instance.

We cannot enter into an account of the mutual attractions and repulsions of atoms or molecules; nor can we discuss the nature of the laws by which these energies manifest themselves. The most subtle and the least understandable of all these indestructible energies is that of electricity. The theory of electricity assumes the existence of two opposite electric fluids, which, in the ordinary or unexcited body, are combined and neutralise one another, but are separated by friction, and flow in opposite directions, accumulating at opposite poles; or, it may be, that one is accumulated at one pole, whilst the other is diffused through some conducting medium and lost sight of. The active electricity, be it positive or negative, thus accumulated at one pole, and retained there by the substance in contact with it being a non-conductor, disturbs by its influence the electrical equilibrium of any body brought near to it, separates

* Ziehen, "Physiolog. Psychol." p. 37.

its two fluids, and attracts the one opposite to itself. This attraction draws the light body towards it until contact ensues, when the electric fluid of the excited body flows into the smaller one, so that its opposite electricity is expelled, and it is in the same condition as its exciter, and, therefore, liable to be repelled by a similar exciter, or attracted by the opposite one, which formerly repelled it.

The ultimate elements of the material universe are generally taken to be ether, energy, and matter. Of ether, the universal all-pervading medium whose tremors or vibrations, propagated as waves, transport the different forms of energy, light, heat, and electricity, across space, we know nothing. Neither can we here discuss the dynamical and statical aspects of energy as it manifests itself in gravity, mechanical work, molecular or atomic force, light, heat, electricity, or magnetism. We are unable even to speculate as to the actual nature of energy itself. Some would hold that energy is the one reality of nature, while others would regard the seventy elementary atoms as ultimate facts. In any case, both matter and energy are indestructible, and their present co-existence is not to be explained by evolution.

We must, however, at any rate, take some account of the activities of the ultimate elements of which the human organism is built. It is impossible to conceive how the human organism can manufacture molecules of living protoplasm like its own out of foreign molecules—*i.e.*, how life manufactures life out of non-living materials. A similar problem awaits us in the analysis of sensation. The molecular motion external to the body becomes transformed into another form of energy—the energy of living matter—whilst that, in turn, becomes the physical counterpart of consciousness.

Dr. Gowers* has recently drawn attention to the source of energy manifested in the animal body and in the processes of human life, and he believes that every form of energy "from a sigh to a convulsion," is derived from "latent chemical energy." He discards the old term "transformation of energy," and substitutes that of the "transition of motion." "We can, I think, perceive all stimuli to be forms of motion. In the case of many physiological stimuli the fact is too obvious to need

* "The Dynamics of Life."

consideration, and I believe that, where it is not obvious, the conception will be found to be one from which there is no escape. If that which is added is motion, it is probable that the energy which this increases is also motion."

It is commonly assumed that nerve-force is of the nature of molecular or atomic motion; it remains, however, for us to ask the question, What is the form of that motion? Dr. Gowers advances the hypothesis that its source is latent chemical energy, conceived as minute motion, liberated and released by added motion. The nerve-endings receive the different vibrations, by which vibrations outward energy presents itself, and which propagate a current or succession of vibrations of nerve-energy along the nerve-fibre. The mechanism by which correspondence is kept up between the living individual and the surrounding universe may appear to be simple; but the notion of its simplicity vanishes when we attempt to comprehend the transformation of the vibrations of outward energy into vibrations of nerve energy, and more especially do we realise our difficulties when we attempt to give an account of a specific motion, of which sensation would be the mental counterpart.

The two chief groups of stimuli are chemical and mechanical. Hermann * believes that magnetism does not act as a nerve-irritant. Ziehen advocates, that the non-nervous elements of the sense-organ, which first receives the external stimulus, act like a sieve, arresting certain qualities of the irritating motions, and permitting certain other qualities to pass on and irritate the nerve-ends. In this way the organs of sense are regarded as possessing the power of selection. In the new-born brain only can pure sensations be experienced. With every subsequent act of mental stimulation the resultant action is made up in part of antecedent effects. In adults the immense number of acquisitions and brain modifications render it almost impossible to realise simple sensations. From an analytic point of view, sensations are thought to differ from perceptions only in the extreme simplicity of the object or content of the former. Sensation's function is that of mere acquaintance with a fact. Perception's function, on the other hand, is knowledge about a fact (James). Sensations involve

* "Pflüger Archiv.," Bd. 43.

nerve-currents coming in from the periphery. In perception it is thought that these nerve-currents arouse associative or reproductive processes in the cortex. Perception would imply the existence of an *ego*; but, inasmuch as the *ego* itself cannot furnish its own material, it also would imply the objective existence of sensations which must be posited as physically-occasioned factors. The mind is, therefore, essentially receptive, and depends upon the material which it is able to absorb and hold within itself. Every subjective state is primarily the result of some mental material construed into an objective external reality. Coupland regards the mind as having no creative power. "Along with laws of an object-world there are laws of the subject-world, and we can only realise, imagine, and interpret in accordance with the fixed subjective conditions."

Modern psychologists challenge the assumptions that the relation of knowledge logically implies two terms, a knower and a known, and that the knower must needs be distinct from the known. The opponents of Mr. Ward conceive consciousness as analogous to light, which in illuminating other objects illuminates itself also.* The greatest objection urged against the theory that conceives consciousness after the analogy of the eye, which sees other objects but cannot see itself, is found in the difficulty with regard to the knowledge of the subject. Professor James attempts to get rid of the difficulty by identifying the knower as the passing state; and he finds that this state, just because it knows, cannot, also, be an object of knowledge. Though the subject cannot know itself at the moment when it knows, it is assumed that it can turn and know itself the moment after. The main line of argument adopted by those who uphold the analogy to light is, that, if the subject be not directly experienced or felt, it is impossible to understand how we ever learn of its existence. Were we to say that the theory of life is to be found in the conception that an organism in vitalising other objects vitalises itself also, we should be quite within bounds; but can we deny the existence of life itself in the abstract merely because its manifestations are the only indications of its existence? We are unable to form any conception as to the nature of life itself in the

* Wundt, "Logik.," ii. 502 ff.

abstract, but merely because we are unable to do so we do not urge a false theory, that because of that inability there is no such thing as life itself. Similarly with consciousness, the mind in illuminating other objects may illuminate itself also. But, we ask, For whom, or to what, does the illumination occur? So long as we deal solely and simply with mental manifestations we can appreciate the analogy; but directly we leave the manifestations and negative the idea of anything beyond, we deny the rights of philosophy to assume that mind itself exists in the abstract, and that we only deal with its manifestations. Later, we shall see that neither the present phenomena nor the representative phenomena of consciousness furnish us with a true explanation of conscious experience. For the present we say of mind indestructible, as we said of life indestructible, that merely because the modes of its behaviour are the only factors with which we are competent to deal, is no argument that there is nothing beyond.

Characters of Sensations.—*Intensity or degree* varies, within certain limits, with the degree or force of a stimulus. The differences in intensity or degree of a sensation instruct our minds as to the nature and structure of bodies, the forces exerted by them, their distance from us, etc. By the application of a graduated series of stimuli to a sense-organ, and by noting the relation of successive increments to the resulting sensation, it has been possible to establish several laws. When a stimulus reaches a certain intensity it results in an appreciable sensation. This point of intensity represents the *liminal intensity*, and the point at which the liminal intensity occurs determines primordially the *absolute sensibility* of an organ or part of an organ.

Whether the method of conduction be mechanical or chemical we are not in a position to say. It is sufficient for us to know, for the present, that the nervous system is in some way or other essential to the conduction of ingoing impulses, and that in some way or other that constitution determines the quality of the sensations.

In the attempt to determine the intensity of a sensation many difficulties are met with: (1) We can only estimate the intensity subjectively, and by comparison of sensations;

(2) we can estimate to a certain extent various external physical motions; but (3) we cannot test the modifications which occur at the peripheral end-organs of sense; nor (4) can we estimate the intensity or nature of an impulse transmitted or propagated through the sensory nerves to the cerebrum; and (5) finally, we cannot estimate the nature of the activities which are immediately concerned with the actual production of consciousness. In order, therefore, to determine the exact relationship between an external stimulus and a sensation we must first establish the proportional relations between the external impulse and its physiological modifications during the transmission from the end-organs of sense to the sensorium. When we speak of the "magnitude of a stimulus" we speak of a force which is capable of external measurement only, and we are totally ignorant of what becomes of that force within the nervous system until it is experienced as a sensation. This is a gap which physiologists will have to fill up before we can bring a brain fact into apposition with a mental fact for the purpose of measurement. From all this the student will readily grasp the fact that, in measuring stimuli, we measure external or physical forces, and not physiological forces. Physiological psychology has sought to bring the psychical fact within measurable distance of the physiological fact, but in reality it has only established a numerical or time relationship between the psychic event and an external physical event, there being an unknown physiological process as an intermediary essential to their effective combination.

We have already seen that an excitation must reach a certain degree of intensity before it can give rise to a sensation, and that this point determines the lower limit of the absolute sensibility of an organ. This absolute sensibility varies considerably—*e.g.*, that of the sense of smell in the dog is greater than that in man. After the point of liminal intensity is passed there is not always a corresponding increase in the intensity of the sensation when the stimulus is increased. No appreciable change need be effected when there is a very slight increase. The additional amount necessary to produce an appreciable difference in the sensation depends on the absolute intensity of the stimulus. A very slight increment to a small stimulus, such as would be sufficient to produce an increase of intensity in the case of a feeble sensation, would, in the case of a powerful one, produce no effect.

The law of Weber or Fechner is:—*In order that the intensity of a sensation may increase in arithmetical progression, the stimulus must increase in geometrical progression.* The amount of the fraction representing the additional amount of stimulus necessary to produce an increase of sensation determines the *discriminative sensibility.* When we reach a point where sensation is no longer capable of increase—*i.e.*, when no further augmentation is perceived—that point is termed the "*maximum of intensity.*" We shall better comprehend this law with the aid of a simple diagram.* E represents the

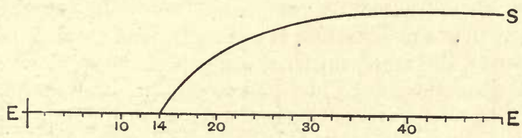

FIG. 13.

first of a series of intensities of excitations. Up to the point 10 the intensity of stimulus is insufficient to cause sensation. At point 14 sensation is first experienced (the liminal intensity). From this point the intensity of the sensation increases with the intensity of the excitation. At a later point, S, although the excitation may continue to be augmented the sensation does not gain in intensity (maximum) but remains constant.

Ziehen shows that the sensation does not increase in proportion to the stimulus when it has just passed the point of liminal intensity. The crescendo of sensation will present a curve that rises at first swiftly and abruptly, then more and more slowly, until it finally vanishes at the point corresponding to the maximum of stimulus, and becomes a straight line parallel to the axis.

These three essential features of the sentient life—the presence of a minimum and maximum of excitation, and finally the increase

* Ziehen, op. cit., p. 47.

of the intensity of the sensation that takes place between the minimum and maximum of stimulation, at first rapidly, and then gradually more slowly—are, according to Ziehen, "exceedingly fitting." "These peculiarities have been developed simply *because* they are fitting in the struggle for existence. Natural selection is just as efficient in the development of psycho-physiological characteristics as in the development of the purely physiological. The existence of a minimum of excitation protects us from an inundation of small stimuli, that would flood the consciousness by their very superabundance, and prevent the employment of the greater, more important stimuli. The existence of a maximum limit of excitation prevents a superabundance of too powerful stimuli, and secures the medium stimuli and their concomitant sensations from being overshadowed and overlooked. Both the distracting preponderance of many insignificant stimuli, and the partiality and tyranny of one or a few too potent stimuli, are avoided by this restriction of the sentient life to a range lying between a maximum and minimum of stimulation."

The first abrupt ascent in the curve of sensation is also regarded as an indication that the sensation is generally fitting. In consequence of this peculiarity, the same author observes—(1) we are very sensitive to those small stimuli that are just sufficient to produce sensation, in fact, we are very liable to overestimate them; (2) we estimate the *medium* stimuli very accurately, since here the curve approaches a straight line; and (3) we begin to lose the ability to distinguish the difference in the intensity of only those stimuli that approach the maximum limit.

Fechner tried to give a *psycho-physical* interpretation of the law of Weber. Many others have tried to give a *physiological* interpretation, but the modifications which the excitation must undergo in its propagation render an exact knowledge impossible. Wundt gives a third interpretation, the *psychological*. He believes that every mental condition is measured in relation to some other by "apperception"—*i.e.*, we become aware of a definite difference only when the increase of one sensation has reached a certain constant fractional part of another sensation that either preceded or accompanied it. This "apperception" faculty has met with severe criticism and is negatived by most observers.

We have seen that Weber's law only holds good in so far as stimuli of medium strength are concerned. As we approach the points of liminal or maximum intensity considerable deviations from it occur. It is now more commonly held, that the sensation increases much more slowly than the stimulus, and that an increase of stimulus sufficient to impart a barely perceptible increment of sensation generally stands in an approximately constant relation to the original magnitude of the stimulus.*

The relation between the sensation and the stimulus is of importance, inasmuch as it allows us to apply something of exact measurement to mental magnitudes. The physiological interpretation involved in the law of Weber will, however, remain as a useful criterion, because the relation of external to internal stimulus, such as that expressed by the law, is as yet only a matter of hypothesis based on the principle of psycho-physical parallelism, and can by no means be proven.† The estimate of magnitude is, therefore, made by comparison; but, it must be remembered that, our sensations only furnish us with measures of relative magnitudes—*i.e.*, we are unable to measure absolute mental magnitudes. This statement holds good in every case; we can only measure relatively by the comparison of magnitudes. Wundt regards the law of the logarithmic relation of sensation to stimulus as a mathematical expression for a psychological process of universal validity. This application of the relativity of sensations to the law of Weber has led Wundt to conclude that, in order that a more intensive sensation-magnitude may increase by as much as a lesser sensation, the sensation-increase must be correspondingly greater; and two sensation-increases which lie at different parts of the sensation-scale will be equally noticeable when they stand in equal relations to the stimulation-intensities to which they are added.‡

The student will now comprehend that, whether a mathematical formula can be successfully applied or not, we cannot eliminate from our calculations the relation of one sensation to other sensations. Psychologically, there is no series of absolutely independent sensations, but every sensation is determined by its relation to the one experienced immediately before it or

* The law of Weber only holds good when attention is given to one sensation of a similar series, to the exclusion of all other sensations.

† Wundt, "Human and Animal Psychology," p. 61.

‡ It is assumed that the "attention" remains a constant quantity. The magnitude of a sensation also depends upon the amount of attention bestowed upon it.

at the same time.* The *law of relativity* is that, from the moment of its first coming into being, the existence and properties of a sensation are determined by its relation to other sensations.†

Quality of Sensations.—When we speak of the "*generic*" quality of a sensation, we use the term in its broad sense to indicate a wide difference of origin (in an orchestra a combination of wood-winds, brass, or strings would indicate a generic quality); when we wish to signify special qualities or finer differences (*e.g.*, modulations of tone in orchestra), we use the term *specific* quality. In the study of the quality of sensations we have to ask ourselves, (1) where does the specific excitation give rise to sensation, and what is the nature of the internal physiological stimulus? We have already said that we are quite unable to answer this question. (2) What kinds of sensations result from the various excitations?

The theory of *qualitative selection* of stimuli by the end-organs of sense has received favour at the hands of most observers. The various sensory nerves are assumed to possess a specific energy that responds only to specific modes of stimulation—*e.g.*, the optic nerves are only sensitive to chemical stimuli produced by the vibration of ether, and the auditory nerves only to acoustic stimuli. We are not in a position to support or to negative this theory. We know that mechanical stimulation of the retina in the dark will produce sparks of light, but no amount of difference in the form of stimulation will produce anything else than the sensation of light. Ziehen believes that the adaptation of nervous elements to inadequate stimuli is accomplished chiefly in the nervous centre. He also believes that to deny the validity of the theory, as thus understood, would be to contradict all the fundamental principles of evolution, which assert that every function determines the character of its organ, or, in a certain sense, trains its organ for its own use. He therefore rejects Wundt's assumption that, all paths

* Höffding, "Outlines of Psychology," p. 112.

† See Wundt, "Animal Psychology"; and for its several applications, "Psychology," Ency. Brit.; Weber, "Tastsinn und Gemeingefühl"; Wagner's "Physiol. Handwörterbuch," iii. 2, p. 544; Fechner "Elemente der Psychophysik," i., p. 174; Schneider, "Vierteljahrsschr. für Wissensch. Philos., ii., p. 411.

and centres are functionally indifferent, and that the processes generated in the central cells are only different because the stimuli are different, and because the irritation is transmitted to the nerve-paths in all its native individuality. That the constitution of the nervous system is an essential factor in determining the quality of sensation we can readily believe; but we do not in the least know where or how that quality is determined.

The **duration** of all sensations bears some relation to the process of nervous stimulation. The correspondence is not always exact. There may be a lingering effect which is termed "*after-sensation*." In sensations of sight we witness such effects as occasional phenomena known as positive after-images.

In addition to the intensity, quality, and duration of sensations we must take account of the tone of feeling that accompanies every sensation. This, however, will occupy our attention later.

A review of the facts in connection with the measurement of sensations leads us to conclude, that (1) statements in proof of the principle of Weber's law are only approximately correct; (2) from the fact that numerous other factors almost constantly mix with or intervene between the quantitative amounts of stimuli and their sensations, stimuli and sensations are not connected quantitatively in such a simple manner that we can measure one off in terms of the other; (3) the psycho-physical explanation of Weber's law, as given by Fechner, is so obscure and speculative that it scarcely merits attention; (4) the psychological explanation alone can account for the facts within consciousness; (5) the various laws about the quantitative and qualitative relations between stimuli and sensations must of necessity be with reference to external physical and internal psychical facts, the intermediary physiological problem being as yet unsolved.

Local Characters of Sensation.—We may arrange the senses in the following ascending order according to their degree of refinement, viz., taste, smell, touch, hearing, sight.

The senses of taste and smell are (1) somewhat similar to the organic sensations, inasmuch as there is in them a want of refinement and definiteness. (2) They are of little use as knowledge-giving senses. (3) They do not aid us in localisation in space. (4) Only under special circumstances do they give exact knowledge about objects (*e.g.*, in wine tasters, etc.). (5) The two senses are easily confused together. (6) Owing to the persistence of these sensations we cannot discriminate two odours and two tastes in rapid succession. (7) Their function is to discriminate what is wholesome or unwholesome to the organism. (8) Their sensations are caused by chemical stimuli. (9) There is with them a predominance of feeling of pleasure or pain.

Sensations of Taste.—The terminations of the gustatory nerves are thought to be only sensitive to chemical stimulation, and it is believed that the sour taste produced by an electric current is caused by the products of electrolysis. The experiments of Bois-Reymond and Rosenthal, however, seem to demonstrate that sensations of taste may be due to electrical stimulation. Usually, four classes of tastes are distinguished—sour, sweet, salt, and bitter. To these Wundt* adds alkaline and metallic. The sensations of taste depend upon several other factors, such as smell, touch, common feeling, and muscular sense. The *intensity* of taste depends upon (1) the *extent* of surface excited; (2) the amount of *mechanical* influence exerted by movements in the mouth; (3) the *temperature* also exerts an important influence. Substances too hot or too cold have diminished intensities of tastes. Weber demonstrated that if the tongue is held for half to one minute in very cold water, or in water of about 125° Fahr., the sweet taste of sugar can no longer be perceived. Whether *specific* sensations of taste can be excited by mechanical or other means is doubtful. Hitherto the attempt to apply Weber's law to the sense of taste has proved a failure, because so many other elements enter into the calculations.

Kiesow† found that, besides the whole surface of the tongue, together with its base and the under surface of its tip—the hard and soft palate, the arcus glosso-palatinus, the tonsils, the uvula, the isthmus faucium, the inside of the epiglottis, and the mucous membrane of the cheeks participate in the sense of

* "Physiol. Psychologie," i., p. 382.

† "Philosophische Studien," Bd. x., Heft. 3, pp. 329 ff.; Heft. 4, pp. 523 ff.

taste. Michelson and Langendorff * tested the sensitiveness of the inner epiglottis; whilst Urbantschitsch tested the mucous membrane of the cheeks in childhood. Kiesow found that all the parts before mentioned are sensitive in childhood; in adults, however, the mucous membrane of the cheeks, the middle of the tongue, and, with a few exceptions, the hard palate lose their sensitiveness. In some cases the under surface of the tip of the tongue on both sides of the frenulum remains receptive also in adults. †

Sensations of Smell.—These sensations are supposed to be caused by minute particles contained in odorous gases or vapours. Whether mechanical, electrical, thermic, or other conditions also excite the sensation of smell is doubtful. If the membrane of the regio olfactoria is soaked with fluid, the sense of smell is lost for a time. A scientific classification of the kinds of smells is almost impossible. Just as with the sense of taste, other factors co-operate with the simple qualities and render a differentiation extremely difficult. The validity of Weber's law has not been tested by the sensations of smell.

Sensations of Touch.—The sensations of touch provide us with much more knowledge of space than those of taste or smell, and it is through this sense that we ascertain, to a large extent, the properties of bodies. The sense of touch is finer in the mobile parts of the body than in the fixed. The discriminative ability of the various parts of the body varies considerably; and, according to Wundt, ‡ the variations in discriminative sensibility at different parts of the same sense-organ do not run parallel to variations in absolute sensibility.

Krohn and Bolton § performed a series of experiments to determine

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* "Centralblatt für Physiol.," 1892, p. 204.

† The great influence in the region of taste Kiesow ascribes to association and the effects of contrast. The total results of his investigations upon the conditions of contrast were that—(1) contrasting stimuli must be recognised in the sense of taste; (2) salt contrasts with sweet, salt with sour, sweet with sour; (3) salt and sweet, and salt and sour, contrast both on simultaneous stimulation of corresponding parts of the tongue, and on successive stimulation of the same taste-surface. The contrasts of sweet and sour could only be observed in the latter case. (4) Bitter forms an exception, but yet perhaps gives rise to contrasts restricted to individuals.

‡ "Physiol. Psychologie," i., cap. 8, § 2, p. 342.

§ "Jour. Nerv. and Ment. Disease," March, 1893.

the relative sensitiveness of different portions of the skin, to find the nature and direction of the errors of localisation, and to study the influence of attention upon the localisation and interpretation of the simultaneous touch stimulations. It was shown—(1) that the skin over the joints is more sensitive than elsewhere, permitting greater accuracy of localisation; (2) that touches on the back are more distinctly felt, more clearly remembered, and therefore better localised than touches on the front of the body; (3) that on the left side touches are not so well localised as on the right side; (4) that localisations are more correct when the touches occur at points removed from the median line—touches on the median line being very poorly located; (5) that exposed surfaces localise better than portions usually covered with clothing; (6) that piliferous parts are more sensitive; (7) that errors in localisation follow certain fixed rules; (8) that the influence of attention is very marked; (9) that the effect of practice is plainly shown; (10) that two pressure-stimulations are often fused into one single sensation, localised at a point removed from either of those at which the stimulations were received; (11) that there is a strong tendency to perceive dermal sensations of purely subjective origin; (12) that bilateral asymmetry of function is plainly evident in dermal sensations.

Sensations of touch involve, to a certain extent, the presence of muscular sensations, and this additional factor renders the results of experiment somewhat untrustworthy. That tactual sensations and sensations of muscular innervation do not agree with the law of Weber, near the lower limits of perceptible intensity, is generally admitted. Weber found that a present sensation could be compared with the mnemonic image of one recently experienced, with greater facility than two present sensations could be compared. A stronger sensation of pressure is experienced when the weight is laid on the left than when it is laid on the corresponding part of the right side. The sensations of touch are held to include not only sensations of contact or pressure, but also those of temperature. Cold and heat are sometimes regarded not as direct caloric stimuli, but only as indirect stimuli by warming and cooling the skin beyond its "physiological zero-point."* Weber's law seems to have little or no application to temperature-sensations. The only qualitative law for sensations of temperature is, that the skin is most sensitive to changes which lie near its own zero-point. Goldschneider† investigated the temperature-sense of

* Zero-point is supposed to be 18·71° C. or 65·66° Fahr.

† "Archiv. f. Anat. u. Physiol., Physiolog. Abth.," 1885, Supplement Band., pp. 60 ff.

the body, and found that the sense of cold is little appreciated by the skin of the head, and the sense of heat only in a few places. The sensitiveness of the forehead to cold is intense, but to heat only moderate; that of the breast to cold moderate along the sternum, and elsewhere very intense, while to heat it is only moderate, except near the nipples; that of the back, everywhere very intense to cold, and only moderate to heat; while in parts of the hand the intensity of sensitiveness to both cold and heat is alike. In general, the skin in the median line of the body seems much less sensitive to changes in temperature than at its sides; and the number of thermic elements, the thickness of the skin, etc., are determining factors.*

Let us now inquire what histology has taught us as to the specific functions of the so-called tactile corpuscles or end-bulbs. Merkel† has given an account of the different kinds of terminal corpuscles. To enter into a description of these varieties, however, is beyond our scope; so we will ask the question briefly, Can the corpuscles of Pacini or Vater, the end-bulbs of Krause, the corpuscles of Wagner or Meissner, or the intricate plexus of non-medullated nerve-fibres of modern histology, be proved to possess specific functions for sensations of pressure or temperature? Ladd answers this question with the statement, that nothing is known on this point beyond the fact that the skin, within which the sensory fibres terminate externally either in free ends or in special tactile corpuscles, is the organ for all the varieties of sensation brought under the most general meaning of the word *touch*.

Whether the sensory impression is received by the end-bulb, or by the peripheral process between the elements of the integumental and other structures, or not, must be decided by physiologists. Schäfer believes, that the sensory impression is not received by the body of the sensory cell, but by a peripheral process, which, passing either to a special end-organ, such as a tactile corpuscle or end-bulb, or insinuating itself between the elements of the integumental and other structures, receives the

* Ladd, "Phys. Psych.," p. 370.

† "Ueber die Endigungen der Sensiblen Nerven in der Haut der Wirbelthiere." Rostok, 1880.

impressions which cause nerve-impulses, and transmits those impulses upwards towards the nerve-centres. It is not only the case with those sensations which are received through the surface of the skin or by the action of the muscles, that sensory impressions are in the first instance communicated to processes of nerve-cells; but the same is true for the auditory and for the gustatory organ, the nerve terminations in which do not, as was at one time supposed, emerge from the receptive hair-cells, but really originate from bi-polar or uni-polar cells which are placed somewhere in the course of the sensory nerve, and which resemble the cells found upon the spinal ganglia in sending a peripheral process to penetrate between the (somewhat modified) cells of the epithelium, and a central process to penetrate the grey matter of the nerve-centres.

In the sensory nerve-trunks a distinction has been made between fibres which have to do with *painful* impressions, and fibres which have to do with ordinary *tactile* impressions, the latter, or tactile group, only having to do with the sensations of pressure and temperature. It has also been thought probable that the sensory and tactile nerves have special perceptive centres in the brain. In support of this view we have the following facts:—(1) Sensory and tactile impressions cannot be discharged at the same time from all the parts which are endowed with special sensibility. Tactile sensations, including pressure and temperature, are only discharged from the coverings of the skin, the mouth, the entrance to and the floor of the nose, the pharynx, the lower end of the rectum and genito-urinary orifices; feeble and indistinct sensations of temperature are felt in the œsophagus. Tactile sensations are absent from all internal viscera, as has been proved in man in cases of gastric, intestinal, and urinary fistulæ. Pain alone can be discharged from these organs. (2) The conduction channels of the tactile and sensory nerves lie in different parts of the spinal cord, which renders probable the assumption that their central and peripheral ends also are different. (3) Very probably the reflex acts discharged by both kinds of nerve-fibres—the tactile and the pathic—are controlled, or even inhibited, by special central nerve-organs. (4) Under pathological conditions, and under the action of narcotics, the one sensation may be suppressed while the other is retained.*

It has been found impossible to classify the various *sensations of pressure.* The pressure sense is supposed to be connected with a specific end-apparatus, arranged in a punctated manner. These points are known as "*pressure spots,*" and possess varying degrees of sensibility. There are supposed to be separate spots for heat, cold, and touch, and it is thought that each nerve-fibre transmits but one sensation. In the back and thigh these spots are marked by a distinct after-sensation. The pressure-spots are, as a rule, denser than the hot and cold spots, and usually have another direction. They vary considerably according to the locality. Kammler and Aubert found the greatest acuteness of sensibility on the forehead, temples, and back of the hand. Eulenburg gave the following order of acuteness: forehead, lips, dorsum of cheeks, temples, etc. The pressure-spots are arranged in chains which radiate from a central point, and run in such directions as to form either circular, longitudinal, or pyramidal figures.† These pressure-spots themselves vary in sensitiveness. The sensation of *after-pressure* is sometimes very marked, and is liable to cause illusory phenomena.

The *temperature* sense also possesses a similar arrangement of spots, known as *temperature-spots.* These spots are insensitive to pressure and pain. They are arranged in a linear series, usually slightly curved, and radiate from certain points of the skin, generally the hair-roots. The chain of cold-spots does not coincide with the hot-spots. Sometimes spots for other qualities of sensation are mixed with them at scattered points. Temperature-spots are always more abundant near the hairs, and sometimes only near them. Cold-spots are more abundant than hot. Sensibility for cold is more responsive and more intense than for warmth; that of the left hand greater than the right.

Common Sensation.—Sensations of pain, hunger, thirst, fatigue, vertigo, well-being, illness, and the innumerable variety of sensations we experience may occur wherever sensory nerves receive an unusual amount of stimulation. No matter in what part

* Landois and Stirling, "Physiology," p. 831.

† Ladd, "Phys. Psych.," p. 346.

of the nerve's course the stimulation is effected, the pain is referred to its peripheral termination. This is the law of the *peripheral reference of sensations.* Pain is seldom strictly uniform or continuous; it is liable to irradiation, or exacerbations in intensity. With increase of nerve-excitability there is apt to be increased intensity of pain, and some nerves are more excitable than others. Our knowledge of the ingoing channels of conduction of pain to the brain is deficient. It is generally supposed that touch, pressure, and temperature impressions travel by the posterior columns, or perhaps in the lateral sensory tracts, or elsewhere. Pain impressions are thought by Bechterew to pass upwards through the lateral sensory tracts. After passing through portions of the posterior columns, they are supposed principally to traverse the grey matter of the cord. All that we do know is, that disease or damage of the posterior columns, as well as of the grey matter, often causes delay in the transmission of such impressions.

Muscular Sense. — The much-vexed question of the relation of the muscular sense to mental states has occupied the attention of nearly every neurologist and psychologist for many years. The muscular sense is defined as "the sum of simple mental states or sensations which immediately accompany the action of the muscles;" and, inasmuch as the muscular sensations are due, not to the action of external objects like sense-impressions, but to our own actions, they are regarded as essentially active states, and so stand in antithesis to the sensations of the five senses which are passive. They have been described as feelings of "effort," "exertion," "energy," "innervation," etc. Some say the sensations arise in connection with the process of "innervation"—*i.e.*, that they are due to the feeling of energy imparted through the efferent nerves. Others say, that the condition is due entirely to sensations arising in the ordinary way and conveyed through the afferent sensory channels. Others, again, maintain, that probably there is a process both of motor innervation and of sensory stimulation involved, and that the degree of innervation determines the intensity of the sensation of effort. The muscular sense is supposed to stand midway between special and common sensations, and by it we obtain a knowledge of the condition of our muscles, and to what extent they are contracted; also the position of the various parts of our bodies and the resistance offered by external objects. On the sensations which are conveyed to the sensorium by the muscular sense we form judgments as to the spatial qualities of objects, and in this respect our muscular sense is intimately related to, and often combined with, the exercise of the senses of touch and sight. Muscular sensibility is apparently absent in the heart and all non-striped muscle; whilst many muscles—*e.g.*, those of respiration—only possess it in a slight degree. The sensibility of the joints, bones, fasciæ, serves to inform us about our "*position*," and this is further aided by sensations of touch. Sensations of *motion* have been distinguished as *active* and *passive*, according to whether we move ourselves or are moved by others. Goldschneider's investigations have made it probable, that the sensation of passive motion depends less upon the successive sensations imparted by different positions of the limb at rest, than upon sensations of pressure or friction in the joints directly imparted by the motion itself. Some authors conclude that the sensibility of the joints is almost the only essential factor in the production of sensations of motion. The combination of sensations of motion with sensations of touch received from the same object is of special importance. The succession of combined sensations of touch and motion is designated as sensation of *active* touch. A distinction has also been made between active and passive touch, by the precedence of motor ideas in the former.

In the following chapter we shall discuss the "perceptions of space," and later still we shall take account of the view of Bastian that "kinæsthetic impressions, and especially those of which we are least conscious, are the last to be reviewed in the cerebral cortex, anterior to, and as actual last links in, the chain of cerebral processes concerned with and previous to the excitation of the motor-centres themselves."

Sensations of Hearing.—The sense of hearing possesses little localising power, and gives us little knowledge of the position of bodies in space, or of their figure and magnitude. Possibly the concha sharpens our hearing very slightly by reflecting vibrations. The external ear in man may be of slight service in localising the direction of sound. Acoustic molecular motions are modified and transmitted by means of the tympanum to the elements of the inner ear. In the labyrinth the acoustic waves become transformed into nerve-commotion by the special end-apparatus of hearing.

How the auditory hairs and stones and cells of the vestibule and ampullæ, the rods of Corti, the fibres of the basilar membrane, and the conical hair-cells of Deiters, in the cochlea perform their required functions of analysis of acoustic oscillations, is beyond our scope to inquire. The sensory impressions are supposed to be communicated in the first instance to the processes of the auditory nerve-cells, and not directly to the cells themselves as in the case of the olfactory cells and the rod-and-cone cells of the retina. In this respect the peripheral reception of their impressions is supposed to resemble those of the tactile and gustatory organs. From the differences in the mode of reception of impressions in the various sense organs—viz., that the sensations received through the skin and from the auditory and gustatory organs are taken up by the terminal branchings of neurons, and that the sensations of light and of smell are taken up by the bodies of nerve-cells themselves—one is tempted, says Schäfer, to generalise from this to the effect that there is some essential difference between the two kinds of receptive organ correlated with differences of function or of excitation. From the observations of Lenhossék* and Retzius,† upon the sensory cells of the earth-worm, such a generalisation is proved to be invalid.‡ When we enter upon the question of the psycho-physics of the auditory sense we find a great wealth of material at our disposal. We are obliged, however, here, as elsewhere, to confine ourselves in the main to the consideration of the relation between the vibratory energy of the air and certain states of consciousness, without attempting to explain the many intermediary links.

The external vibratory stimuli which determine the subjective mental state, "sound," have been more or less accurately

* "Arch. für Mikr. Anatomie," 1892, Bd. xxxix.

† "Biologische Untersuchungen," Neue Folge, 1892, Bd. iii.

‡ See Schäfer, "Brain," 1893, p. 162.

investigated. From a psychical point of view the various sounds have been divided into two classes—viz., *tones*, or musical sounds, due to periodic or rhythmical motions of sonorous bodies; and *noises*, due to non-periodic motions. Objectively considered, tones and noises invariably accompany one another in some degree; subjectively considered, the preponderance of the one over the other gives the feeling of pleasure or the reverse. Since all sounds are for us the subjective result of various combinations of tones, both musical sounds and noises may be reduced to a general form of vibration termed in physics a "*sinusoid.*"

Sounds of a musical character—that is, sounds which present an appreciable consistency in their rapidity of vibration—depend for their pitch upon the number of vibrations, and for their intensity upon the amplitude of those vibrations. When the rate of vibration is doubled, the octave of the fundamental note is produced. Sounds whose relativity of vibration can be expressed by the simple numerical ratios are perceived, when blended, to be harmonious. Other combinations are more or less discordant. The quality of a musical sound, the *timbre* of a musical instrument, depend upon the number of over-tones or partial tones involved. Thus, there are more partial tones in a violin tone than in the corresponding flute tone, etc.

Musical sounds may vary in loudness, pitch, and quality. These three conditions determine the sound. The pitch of a sound is determined by the number of aërial vibrations executed in a given time. The lowest vibration-number which can be termed musical is about 16 per second. The musical character continues imperfect until about 40 vibrations per second are reached. The powers of sensory discrimination vary considerably in different individuals. Some fail in the upper registers, others in the lower. The highest note of the piccolo (4,752 vibrations per second) is practically the superior limit to the scale of pitch in music. If above this degree of acuteness the sound becomes painful. Some individuals possess a fine discrimination for the detection of over-tones; others acquire the power by training. Habit or experience does much, but not all. A good piccolo player would experience greater difficulty in tuning a "double-bass" than in tuning his own instrument, and *vice versâ*.

The ear is capable of analysing complex aërial waves, thus enabling us to perceive the elements of which they are compounded. The aërial wave which reaches the ear at any moment is the summation of the individual systems of waves which are in course of propagation in the vicinity at the time. For instance, the sounds produced in an orchestra are extremely varied, but the aërial waves arising from each instrument, as a centre, are superposed, and arrive at the ear as a wave of great complexity. The ear, however, differentiates this intricate combination into simpler elements, and we are enabled to distinguish the sound of the violin from that of the clarionet, etc.

In addition to adequate stimuli affecting the end organ of sense, various sensations of sound may arise in connection with electric stimulation of the auditory nerve, or disease of the cerebrum. These subjective effects are, however, simple and often indistinct, until, by repetition, and by a mental preparedness or expectancy, the attention evolves them into definite tones or noises having a subjective equivalence to sounds determined by external vibratory causes. The psychological aspects of auditory sensations do not differ in the main from those of other sensations. We must assume a power of sensory discrimination within the mind itself. We shall see later that muscular sensations do not entirely account for all the power of the mind in this direction; nor can we say that the mind is, in some cases, dependent at all upon the addition of visual spatial relations.

The psycho-physical aspects of feeling associated with musical sounds and noises, as investigated by Helmholtz,* give a negative reason for the feeling of dissonance—*i.e.*, the feeling of consonance is due to absence of the successive shocks or "beats," which occur less frequently, but more decidedly and unpleasantly as the pitch of the notes becomes more nearly the same.†

* "Sensations of Tone," p. 255 f.

† "*Beats*" in music are due to the alternate coincidence and interference of two systems of sonorous waves. When two sonorous bodies, whose

In all marked dissonances such beats occur at the rate of from 20 to 40 per second. The most perfect consonance of two tones results from a note and its octave. Here the coincidence or interference of the vibrations is very frequent, for whilst the one note performs one vibration, the octave performs two, and thus there are no beats perceptible. On the other hand, a most unpleasant discord is produced by two notes differing by a semitone—in this case there is great infrequency in the coincidence or interference of the vibrations—and the beats become very marked. Helmholtz found that, as long as no more than four to six beats occur in a second, the ear readily distinguishes the alternate reinforcements of the tone. If the beats be more rapid, the tones grate on the ear, or they become cutting. Roughness of tone is the essential character of dissonance. He also found, that even when the fundamental tones have such widely different pitches that they cannot produce audible beats, the upper partial tones (over-tones) may beat and make the tone rough.

Pettingen gives a *positive* reason—*i.e.*, that the consonance or pleasantness of harmony is due to *tonicity* and *phonicity* of certain intervals and combined notes. Tonicity is the property of being recognised as a constituent of a *single* fundamental tone, which is designated by the name "tonic." Phonicity is that property of a chord or interval which consists in the possession of certain partial tones that are common to all tones. The first of these qualities of harmony seems to ally the pleasure it yields to that which follows even the obscure and only half-conscious perception, as it were, of all relations, as such, between our sensations.

The law of Weber, as applied to sensations of sound, has

periods of vibration slightly differ, emit sound together, at first the condensations and rarefactions which they separately produce in the air coincide, causing an increase in the sound. After a short time, however, the condensation produced by the one body encounters the rarefaction produced by the other, and there results a mutual interference, which causes a partial destruction of the sound. Coincidence sets in a second time, to be followed by another interference, and so on. Thus, whilst the bodies continue sounding, there will be an alternate increase and diminution of the sound, caused by the coalescence and interference of the vibrations respectively; it is these alternations of loudness and faintness that get the name of "beats."

given rise to much misconception. By this law we can only compare the intensity of a stimulus with the intensity of a sensation, and we must not include qualitative effects amongst the sensations. The sensation of pitch has nothing to do with the intensity of the sensation, nor has the number of vibrations anything to do with the intensity of the acoustic stimulus. Weber's law is held to be comparatively exact for the intensity of acoustic sensations. The intensity of sound depends upon (1) the distance of the individual from the sounding body. The law of inverse squares is, that in free homogeneous air the intensity varies inversely as the square of the distance. Thus, the distance being as, 1, 2 3, 4, $\frac{1}{2}$, $\frac{1}{3}$, the intensities are as, 1, $\frac{1}{4}$, $\frac{1}{9}$, $\frac{1}{16}$, 4, 9. (2) The density of the air in which the sound is generated, not upon that in which it is heard; (3) the amplitude of the vibration—*i.e.*, the intensity is in proportion to the square of the amplitude. Thus, the amplitude being as 1, 2, 3, 4, $\frac{1}{2}$, $\frac{1}{3}$, the intensities are as 1, 4, 9, 16, $\frac{1}{4}$, $\frac{1}{9}$.

To the question as to whether the same acoustic stimulus can act on several nerve-terminations, or whether there is qualitative adaptation of the auditory fibres, so that no two fibres can partake of the same kind of excitation, we shall return when we discuss the power of discrimination of spatial relations.

Sensations of Sight.—The transverse vibrations of ether, which are supposed to diffuse light through space, impart sensations of light to the eye. By the periodic vibrations of these particles of ether our mental vision is thought to be governed in a somewhat similar manner to the mode in which our mental ear is governed by the vibrations of sound. This idea has given rise to the theory, that consciousness is analogous to light, which, in illuminating other objects, illuminates itself also.* Of this theory, and of the other, which regards consciousness as the analogue of the eye itself, which sees other objects, but cannot see itself, we shall have more to say later. Let us now see what data we have for the construction of an intelligible account of the phenomena of vision.

The cornea, aqueous humour, crystalline lens, and vitreous

* Cf. Wundt, "Logik.," ii. 502 ff.

humour, form the four translucent refracting media of the eye; their function is to transmit and apply the external stimulus to the retina in the form of an image, and in an order corresponding to the external object. To trace the course of the rays of light through these media, and to give an account of their indices of refraction, and of the geometrical form and position of their limiting surfaces, is beyond the scope of this work. It must suffice for us to recognise that each refracting surface is separate, and that each one of these refractive media plays its part in projecting an inverted diminished image of the objects of the external world upon the retina. The construction of the inverted image upon the retina is comparatively simple; but, as the retinal image is inverted, we have to explain how it is that objects appear *upright* to us. The impulses from any point of the retina are referred by the mind, to the exterior, in the direction through the nodal point. The image appears to be external, because all points appear to lie in a surface floating in front of the eye (the "field of vision"). The field of vision is the inverted surface of the retina projected externally; hence the field of vision appears erect again, as the inverted retinal image is again projected externally. With the formation of an image upon the retina we have to give an account of a corresponding physiological process which would serve to conduct the external impression to the sensorium. The retina has to solve the unknown photo-chemical process. Somewhere within the nervous and other elements of the retina must be found the specific end apparatus which receives the external stimuli and modifies them into physiological processes. Anatomists and physiologists refer to the layer of rods and cones as the elements which appear to be directly affected by the action of light. A chemical process is regarded, by most observers, as insufficient. A photo-chemical process is, however, considered as furnishing the best hypothesis.

In an ordinary act of vision the external vibratory stimuli determine various photo-chemical retinal effects. The nerve-ends in some way become affected, and transmit or set up excitations, which are conducted to the cerebrum. At present there is considerable doubt as to what visual substances are decomposed in the photo-chemical process.

The *pigmentum nigrum* is supposed to be of importance in the formation of visual sensations, and the so-called *visual purple* is thought to be related in some way to the susceptibility of the eye for different colours.

When the eye-ball is pressed we get the so-called "*phosphenes*," or "pressure-pictures." The impression is always referred externally, and is always perceived on the side of the field of vision opposite to where the pressure affects the retina —*e.g.*, pressure upon the outer surface of the eyeball causes the flash of light to appear on the inner side. If the retina is not well lighted, the phosphene appears luminous; if it is well lighted the phosphene appears as a dark speck, within which the visual perception is momentarily abolished. Purkinje pointed out that if a uniform pressure be applied to the eyeball continuously, from before backwards, after some time there appear sparkling variable figures, somewhat kaleidoscopic in effect. By applying steady and continuous pressure, Steinbach and Purkinje observed a network with moving contents of a bluish-silvery colour, which seemed to correspond to the retinal veins. Vierordt and Laiblin observed the branching of the blood-vessels of the choroid as a red net-work upon a black ground. Houdin believes we may detect the position of the yellow spot by pressure upon the eyeball. Mechanical and electrical stimuli, when applied to any part of the course of the visual tracts, are liable to cause visual phenomena, although the resulting phenomenon has not the same intensity or clearness as when the cause is due to activity of the ethereal vibrations.

Quality of sensations of sight.—Under this heading we shall have to consider chiefly the sensations of colour and light. These impressions fall into a series of gradual changes, varying, for the most part, with the changes in rapidity of the vibratory stimulus. This is not an invariable rule, however, for considerable variations may occur in the rate of vibration without an appreciable corresponding effect on the sensation. Hence, the quality of the sensation cannot be said to correspond so exactly with changes in the stimulus as was the case with tone sensations. The degree of colour is dependent upon the proportion of white light to the special kind of light. Thus, differences in degrees of saturation of the spectral colours cause considerable variations in the quality of the sensations. Similarly, the size of the coloured object and the resulting breadth of the sensation, as well as the intensity of the stimulus, and the time during which it acts, also affect the quality of the sensation. Further, the same stimulus produces different sensations as it falls upon different portions of a normal retina (Ladd). The fineness of discrimination varies with different parts of the retina. From a quantitative point of view the central area, or the area of perfect vision, is more discriminative than the side parts of the retina. The discrimination of degree is much less fine when coloured light is employed.*

Light is the chief stimulus which acts upon the retinal elements. Some observers hold, that the retina has a light of its own, which is due to the ever-active tonic excitation of its nervous elements by the chemical constituents of the blood. Spectral colours may be arranged in the following order: red, orange, yellow, green, blue, violet. If a beam of white light be transmitted through a prism, the light rays are refracted and dispersed. The dark heat-rays are refracted least; they are invisible to the retina. The oscillations of the light-ether excite the retina in the following order (of billions per second): red, 481; orange, 532; yellow, 563; green, 607; blue, 653; indigo, 676; violet, 764. The sensations of colour would thus depend upon the number of vibrations of the light ether. The series of colours obtained by the aid of a prism do not, however, include the innumerable shades and varieties of colour with which our sensations are furnished; nor can we account for all the variations in the quality of our sensations from the point of view of intensity or rapidity of vibration of the stimulus.

Simple and mixed colours.—The *simple* colours are those of the spectrum; and to the vibrations of which the retina has a corresponding excitation. *Mixed* colours are those whose sensations are produced when the retina is excited by two or more simple colours. The colour *white* is a mixture of all the colours of the spectrum. When two spectral colours act together and give the colour white, they are said to be complementary to each other, or "*complemental colours*." Any two colours which,

* Wundt, "Physiolog. Psychologie," i. cap. 8, § 2, p. 335.

when mixed, supplement the prevailing tone of the light are termed *contrast* colours. When a colour is simple and free from mixture with other colours, its *colour-tone* is said to be *pure* or *saturated.* The colour-tones of the spectrum pass imperceptibly into one another; and the fact that the *ultra*-red and *ultra*-violet rays do not excite visual sensations is thought to be due to the structure of the retina. Mixed colour-impressions vary with the intensity of the various components. Taking into account the number of colour-tones distinguishable by the human eye, together with their variations due to differences in brightness and intensity, Von Kries estimates that there are about 500,000 to 600,000 colour sensations. At the minimum of intensity of light every colour-tone, except the pure red of spectral saturation, appears colourless when seen alone on a perfectly black ground. The different colours appear and disappear at different degrees of intensity of the stimulus; green remains visible in the weakest light. Before the maximum of intensity is reached, red and green pass over into yellow; whilst at the maximum all sensations of colour-tone cease, and even homogeneous rays appear white.

Colour-blindness appears to be due to a defective structure of the retina. The most common form is where the spectrum is shortened at the red end. Fick states, that the farther outward this imperfect condition of the retina extends, the nearer does the defect approach to total colour-blindness. Kries estimates that colour-blind persons are reduced to colours which are either red and blue-green, or greenish-yellow and blue-violet. In total colour-blindness only shades of grey from white to black may be visible.* Violet *colour*-blindness is comparatively infrequent. It has been observed after the administration of santonin. Those who have red-blindness see only blue and yellow; red, orange, and green appear like yellow, and violet like blue. Those who are colour-blind to green see all colours as blue and red.

* When the image of an object remains active upon the retina and corresponds to the primary image, this image is termed a *positive after-image;* a *negative after-image* is due to the exhaustion of the retinal elements, and is made up of the complementary colours of the objects.

Theories of Colour-Sensation.—1. The *Young-Helmholtz* theory* assumes the presence of three different kinds of nerve-elements corresponding to the three primary colours—red, green, and violet—in the retina. This theory also assumes that, every colour of the spectrum excites all the kinds of fibres, some of them feebly, others strongly. The elements sensitive to red are most strongly excited by light with the longest wave length, the red rays; those for green by green rays of medium wave length; those for violet by the rays of shortest wave length, violet rays. The rods of the retina are said to be concerned only with the capacity to distinguish quantitative sensations of light. This hypothesis, that there are three special kinds of fibre in the optic-nerve, is quite uncertain, and it does not aid us in the least, from a psychological point of view. Ziehen believes, that all terminations of the nerve-fibres in the central parts of the retina must be very sensitive to many, if not to all, colour stimuli. The theory would explain many of the sensations of light and colour, especially those relating to mixed and complementary colours; but it does not account sufficiently for the facts of contrast and colour-blindness.

2. The *Hering theory*† assumes, that there are six fundamental colour-tones—viz., black and white, green and red, blue and yellow. These three pairs of colours are regarded as antagonistic, the one to the other. The changes which give rise to sensations of black, green, and blue, are assumed to be due to the process of "construction" of a so-called visual substance; those which give rise to white, red, and yellow are due to the "destruction" of such visual substance.

3. *The theory of Wundt.*‡—(1) In every retinal excitation there is a *chromatic* and an *achromatic* process set up. (2) The achromatic excitation consists in a uniform photo-chemical process, which reaches its maximum at yellow, and falls off towards both ends of the spectrum. (3) The chromatic excitation is a polyform photo-chemical process, which changes continuously with the wave-lengths of light. The extreme differences of this length are such as to produce effects that

* Helmholtz, "Physiolog. Optik."

† "Zur Lehre vom Lichtsinne, Sitzgsber. d. Wiener Acad.," 1872—1874.

‡ "Physiolog. Psychologie," i. pp. 450 ff.

approximate to each other; while the effects of certain different intervening wave-lengths are related in such a way, that opposed phases of one and the same movement equalise each other perfectly. (4) Every process of excitation of the retina outlasts the stimulation for a certain time, and exhausts the sensibility of the nerve-substance for that particular form of stimulation. The positive after-images are due to the persistence of the retinal excitation—the negative to exhaustion. (5) The phenomena of contrast are to be explained by the law of relativity.

4. *The theory of Von Kries.**—(1) Three series of components are requisite—one for the bright and dark, but colourless, sensations; and two colour-tone series, a red green-series, and a yellow blue-series. (2) White is not to be considered as belonging to the three, since it corresponds to all the colour-tones, whenever they reach a minimum of saturation. (3) The processes corresponding to these three series of components may be located at different places in the nervous apparatus of vision, either more centrally or more peripherally. (4) The articulation and adjustment of these three processes are assigned to the central organs.

5. *The Franklin theory*† is (1) that in its earliest stage of development, vision consisted of nothing but a sensation of grey (the word grey covering the whole series black-grey-white). (2). This sensation of grey was brought about by the action upon the nerve-ends of a certain chemical substance set free in the retina under the influence of light. (3) In the course of development of the visual sense, the molecule to be chemically decomposed became so differentiated as to be capable of losing only a part of its exciting substance at once; three chemical constituents of the excitant of the grey sensation can, therefore, now be present separately (under the influence of three different parts of the spectrum respectively), and they severally cause the sensation of red, green, and blue. (4) But when all three of these substances are present at once, they re-combine to produce the excitant of the grey sensation, and thus it happens, that the objective mixing of three colours, in

* "Archiv. f. Anat. u. Physiol., Abth.," 1882, Appendix, pp. 1—178.

† "International Congress of Experimental Psychology," London, 1892.

proper proportions, gives a sensation of no *colour* at all, but only grey.

Göller * has given a physical theory, and Donders † a chemical one somewhat like that of Franklin. The distribution of the rods and cones corresponds exactly with the distribution of sensitiveness to just perceptible light and colour excitations,‡ and this fact is what we might expect, if we assume, with Franklin, that the rods contain the undeveloped molecules which give us the sensation of grey only, while the cones contain the colour molecules, which cause sensations of grey and of colour both.

All the theories hitherto advanced are, of necessity, based upon unverifiable hypotheses. The difficulty in all colour-sensation theories is to account for the fact, that any two complemental colours lose themselves in a totally different sensation, and that other sensation-pairs, indistinguishable from these objectively, do nothing of the sort. The physiological requirements would appear to be better met by the theory of Franklin than by that either of Helmholtz or Hering.§ The chief advantage of the theory is shared by that of Donders, which also assumes the partial decomposition of the photo-chemical substance. Sandford ‖ raises the objections (1) that the theory does not account for black, especially for black in simultaneous contrast. (2) Granting that the retinal circulation is rapid enough for the use made of it in explaining simultaneous contrasts, how is the reversal of colours, which is found in the after image of the contrasting field, to be accounted for? Franklin, however, accounts for the sensation of black as the effect on the nerve-ends of the resting condition of the photo-chemical substance; it is, therefore, the antithesis to every colour as well as to white, and it is the constant background against which all colours and white are seen. In reply to the objection to the explanation of simultaneous contrast, the phenomena is attributed to a purposeful reflex action.

* "Du Bois Reymond's Archiv.," 1889.

† Gräfe, "Archiv. für Ophthalmologie," B.S. 30 (1), 1884.

‡ Fick, "Pflüger's Archiv.," Bd. xliv. s. 441, 1888.

§ Burdon-Sanderson, "Nature," vol. 48, p. 469.

‖ "Pysch. Rev.," Jan. 1894, p. 99.

In concluding this chapter we may say that, before we can hope to establish a psycho-physiological formula which shall embrace the relationship of the physical activities to the actual sensation (1) we must determine more particularly how the different parts of the retina are arranged together spatially; (2) we must endeavour to explain how the physical vibrations of ether, the modes of refraction of the eye, and the spectral characters of light, determine physiological nerve excitation; (3) we must further test the validity of Weber's law when applied to the intensity of visual sensations;* (4) we must determine the anatomical relations of the visual path more accurately. We believe that the external geniculate body, the pulvinar, and the corpora quadrigemina anterior, all receive fibres from the optic tracts, but it is uncertain whether they all receive visual fibres. The occipital visual path, the exact centre for vision, and the functions of a great part of the occipital cortex and angular gyrus, are not yet well known.

* The researches of Fechner, Merkel, König, and Broohun demonstrate that in the case of light stimuli of medium intensity the law of Weber is approximately correct. Deviations occur at the "lower deviation," and owing to the retina's own light.

CHAPTER VII.

Perception.

Perception—External and Internal Perception—Apperception—Physiological Conditions of Perception—Space Form—Nativistic and Empiristic Theories of Perception—Perception of Spatial Order—Theory of Local Signs—Eccentric Projection of Sensations—Spatial Discrimination—Special Channels of Perception: Perceptions of Smell and Taste; Hearing; Touch; Muscular Sensation; Sight (Retinal, Monocular, Binocular).

When we refer sensations to objects in space—that is to say, when we localise or externalise them—we attribute some quality to a particular object in space as distinct from the mind which perceives it. *Perception* is this process of localising sensations and referring them to definite objects, and the result of this process is usually called a *percept.* This acceptation of the term is, perhaps, more convenient than the one of some psychologists, which includes sensation and perception as part of the same process. This process of perceiving sensations and referring them to the outer world is sometimes called *external* or *sense perception,* to distinguish it from the cognition of the mind's own states which is termed *internal perception.* Perception is more an act of mind than sensation, which is passive. Early writers employed the term in a wide sense; recent writers restrict the word to that act of the mind by which we discern an external object by way of the senses.* Perception is, therefore, a mental process which involves the analysis of a number of sense-data. Wundt has divided perception into *simple* perception and *apperception;* the former being the simple apprehension that we are somehow mentally affected, the latter

* Sully, "Outlines of Psychology."

being the mental state after discerning attention has been given by the observer to the sense data.* Perception is the invariable accompaniment of sensation, inasmuch as every sensation is, more or less, referred to some position in space. This perceptual or localising interpretation may be slight when the sensation is little attended to, but it occurs nevertheless even in the remote regions of diffuse consciousness. Thus, when we analyse the perceptual process we find that a sensation is first discriminated as a sensation; then it is identified as pertaining to some particular kind of object, and this involves a germ of *representation*, or the recalling of other sense-impressions gained by past experience. A perception is, therefore, a complex mental act of which sensations form the component factors. Spencer† regards perception as a "*presentative representative* process" because it contains a presentative element—the actual sensation—and also a number of recalled or representative elements. Wundt does not regard the representative element as essential to perception. Several others speak of percepts in their totality as presentation. For our part, the only percept which we can consider as not involving a representative element, is that attending the first sensation of life; every subsequent percept or process of external reference to sensation is the sum total of previous acquisitions; and a representative element is more or less consciously combined with the presentative element in every psychical perceptual act. Perception, as defined by Sully, is "a complex mental act or process, involving presentative and representative elements." "Perception is that process by which the mind, after discriminating and identifying a sense-impression (simple or complex) supplements it by an accompaniment or escort of revived sensations, the whole aggregate of actual and revived sensations being solidified or integrated into the form of a percept—that is, an apparently immediate apprehension or cognition of an object now present in a particular locality or region of space."

Physiological Conditions of Perception.—An act of perception involves the co-operation of different motor as well as sensory-centres. The element of attention is attended

* "Tuke's Dict. of Psych. Med.," p. 923.

† "Principles of Psychology," vol. ii., part VIII., ch. II., p. 513.

by certain activities of the motor elements. The nervous accompaniments are, therefore, much more complex than in the case of simple sensation. Since sensations themselves are the elements of the so-called presentations of sense, we are forced to accept sensations as the data upon which mental products are formed. Thus sensations are the mental factors upon which the development of all psychical states depends.

In regard to the ideas of "space," "time" (and the "moral sense"), it may be well to say, at the outset, that no attempt will be made in this work to determine whether such perceptions, in their ultimate essence, can be resolved into mere transcendental faculties and functional processes of mind. To the physiologist, above all other men, it would appear to be clear that, whatever may be the ultimate foundations of their existence, as associated with other causes and effects of our physical and mental life than those we know, the mode of their appearance with us is distinctly empirical, and depends directly, in regard to each psychic manifestation, upon the quality and combinations of the stimuli both exoneural and esoneural, which give rise to that manifestation. And, therefore, following in the footsteps of those workers who have given their attention to the distinctly practical side of this subject, it will be sufficient, for our purpose, to inquire how the appearance of these modes seems to become manifest through excitations of the special organs of sense, external and internal, and through the combination of the effects of such excitations.

Presentations of sense differ from simple sensations, in that they exhibit the psychical power of estimating space form. In order to explain on what combinations of physical processes of sense, the different resulting sensations are combined into presentations of sense under the new characteristic of space-form. the following truths are to be recognised :—*

1. A combination of two or more qualitatively different series of sensations is necessary.

2. There must be adaptability of special senses to form a graded series of the characteristic differences in quality of sensations (*e.g.*, spatial series of sight and touch), called the geometrical senses.

* Ladd, "Phys. Psych.," p. 385

3. There must be a mental representative in the sensations which stimulation of the different parts of the organ of sense calls forth (the theory of "*local signs*").

4. Various stages in the process of elaborating the presentations of sense, from the material of simple sensations, must be recognised. These stages are (*a*) *localisation*, or the transference of the composite sensations from mere states of the mind, to processes or conditions associated with more or less definitely fixed points or areas of the body; and (*b*) *eccentric projection*, or the giving to these sensations an objective existence as qualities of objects situated within a field of space, and in contact with, or more or less remotely distinct from, the body. The law of eccentric projection is, "Objects are perceived in space as situated in a right line off the ends of the nerve-fibres which they irritate."

5. A constant activity of mind is presupposed, whereby presentations of sense are elaborated (by synthesis) by the mind itself.

Theories as to the **origin of presentations** of sense.—Two theories have been given to account for the genesis of presentations, and these have been termed the 'nativistic,' and 'empiristic.' The *nativistic* theory (Helmholtz) assumes the presence of an intuitive or underived activity of the mind, which enables the mind to appreciate the characters of the presentations of sense by force of its own inherent fundamental capabilities. It also assumes that a definite point in space is allotted to each of the retinal points from birth, which would account for some of the spatial relations of presentations. The *empiristic* or *genetic* theory objects to the mind's native intuition. It denies the native power of the mind to intuit space, and relies upon kinæsthetic, muscular, and tactual sensations to account for the spatial phenomena. The advocates of either of these theories must admit, that sensations are presentations to the mind, and that unless the mind perceives them they are not presentations. The perceptual power of the mind is dependent upon the presentations of sense for its development, but the individual presentations do not mass themselves into a "mind-stuff" which corresponds to perception; that is to say, the sensations do not present themselves to themselves, and by their combination evolve perception.

No matter how much the empiristic school advocates the laws of development, it must still admit the so-called native power of the mind as that which perceives. Ziehen adopts the genetic standpoint to account for the spatial relations of sight, but he admits that in the course of the phylogenetic development of the animal series, that capacity to localise visual sensations was first developed, which made the eye a proper organ for the perception of space. He says, "We find the wonderful rapidity with which this arrangement of the sensations is accomplished inconceivable; at once, without a moment's thought, the image is before us, well arranged and unmarred by the slightest error. To be sure, a process of evolution, extending through almost endless ages, was necessary to produce and train a cortical apparatus that can react with such fitness. The new-born animal or child inherits this apparatus. Each single individual does not need to acquire it again laboriously, but only to learn to use it." This attempt to shift the native power to the ancestry must be the method of procedure of all empiristics. The nervous organism of every child probably does inherit an innate power of co-ordinating certain retinal sensations with sensations of ocular movement, and visual sensations with experiences of active touch; by a slow process of acquisition, however, the muscular and tactual sensations become more or less absorbed in the visual elements, so that the comprehensive range of vision far exceeds, and becomes in a manner independent of, the muscular and touch elements. This hypothesis of inherited tendency accords more with the theory of an original intuitive knowledge, than with the opposite theory of a derived space-intuition.

Schopenhauer, Spencer, Hartmann, Wundt, Helmholtz, and Buret, have held the opinion, that perception is a sort of reasoning operation, more or less unconsciously and automatically performed, which is equivalent to saying that the characters, qualitative and spatial, of external objects are treated, combined, and arranged, by the nervous apparatus, and handed to consciousness in their new form as fully developed percepts.

We have already mentioned that the localisation of organic visceral sensations is confused and indistinct. The exoneural reference by the special senses is much more accurate and defined. The mind passes from the mental phenomenon, the sensation, to the contemplation of the object which it serves to qualify. The theory, that in sensations of hearing, touch, sight, and pain, we are accustomed to distinguish from among the other elements the elements of *voluminousness*, has much in its favour. Professor James holds, that this element of voluminousness is discernible in each and every sensation, though more developed in some than in others, and that it is the original sensation of space, out of which all the exact knowledge about space that we afterwards come to have is woven by processes of discrimination, association, and selection.

The perception of spatial order.—To account for the order in which space perceptions are arranged in our minds, two theories have been advocated.

1. By the one, the spatial order would appear to result from the massing together of a multitude of sense-space phenomena in consciousness, and this, through the intervention of physiological processes, equivalent to the processes of the "mind-stuffists." Thus the abstract phenomenon of spatial order is supposed to be formed by the synthesis of concrete perceptions; the physiological processes, which correspond to the estimation of figures, magnitudes, and distances, are held to combine in an orderly way, giving, as the result of their combination, an abstract apprehension of spatial order.

2. The other theory assumes that, for the orderly arrangement of a multitude of sense-spaces in consciousness, something more than their mere separate existence is required. In order that a sensation may be discriminated spatially, it is essential that the various extents of the objects should be perceived as part of the total extent. This would imply, either that the various extents are perceived in a definite order, or that they are perceived by the mind synchronously, and at once. The difficulty, therefore, arises of having to account for the discrimination not only of co-existent spatial extents, but also of co-existent sounds and extents of other senses.

Some authors uphold the view that a new element comes into play when the mind estimates or perceives some spatial relation. The relation, when perceived, however, is nothing more than a sensation which is perceived. That is to say, the relation of two bodies in space, the line of demarcation between the two, or the particular forms of transition between two sensations, are as definitely sensational, in their subjective aspects, as the sensations of all related bodies themselves. Spatial knowledge, therefore, like every other form of knowledge, as we know it, depends upon sensations. The mind would appear to pass from its comprehensive view of the vaster extents to an analysis of spatial relations in detail.

Localisation, or the theory of "local signs." — It is assumed, that every visual and tactual sensation derives its peculiar shade of feeling from the peculiarities of the end-organ of sense stimulated. These local contrasts of sensations have been termed "*specific qualia*," "*local-colourings*," or "*local signs*." In referring to a local sign, we refer to a thing having a position in space, and this is determined by its relations to other positions in space. When we refer to two separate points we become aware of an interval, which is unexcited, between the two points. We can localise one point only in its relation to the whole body, and two points in their relation to each other. In both cases, however, we refer the points to some part of a visual image of the body. In an ordinary way we are apt to utilise the fittest part of our sensory mechanism to discriminate sensory events. We employ the most sensitive parts of our limbs to investigate the nature of a local stimulus, and in a similar way the fovea and yellow spot of the retina are employed when we wish to focus our attention more particularly upon some visual object. The movement bringing the fovea into direct action involves a transition of action from the retinal elements first stimulated to the elements possessing greater discriminative sensibility. In this way we get an "*ideal streak*" (James) awakened first at the point of retinal stimulation and extended to the centre of focus. Professor James believes that the result of this incessant tracing of radii is, that whenever a local sign is awakened by a spot of light falling upon it, it recalls forthwith, even though the eyeball be unmoved, the local signs of all the other points which lie between the first spots stimulated and the fovea. In this way no ray of light can fall on any retinal spot without the local sign of that spot revealing to us, by recalling the line of its most habitual associates, its direction and distance from the centre of the field. The fovea is thus regarded as the origin of a system of "polar co-ordinates," in relation to which each and every retinal point has, through an incessantly repeated process of association, its distance and direction determined.

The physical basis of this process of localising by local signs is, therefore, supposed to depend upon the connection between sensory and motor nerves; and, according to Lotze, the local character of every colour-impression is due to the excitations of the central endings of the motor nerves, and the sign determines the motor tendencies, or associated feelings of movement. The theory of local signs, as applied to tactual sensations, has received much attention, and it is regarded as comparatively certain that local signs facilitate the localisation of sensations of pressure, and that the same stimulus, acting upon different nerve-fibres separately, also causes a slightly perceptible difference in quality of the resulting sensation. From these considerations we are now in a position to recognise, that the capability of localisation of sensations of sight and of pressure is due to the difference in the sensations produced when a stimulus acts upon different nerve-ends separately. The localisation is brought about by the aid of association. The mere sensation in itself is insufficient; it only aids us in localising by means of its local sign, and this again is further aided by its relativity as evidenced through the "ideal-streak."

Eccentric Projection of Sensation.—How a sensation can be projected into space is quite inconceivable. We are not warranted in assuming that a sensation becomes manifested psychically in the region of the bodily processes from which it has its starting point. Sensations are the mental equivalents of cerebral processes, and these cerebral processes are the physiological effects of physically-determined processes elsewhere. The eccentric projection of sensations is thought to involve a somewhat different class of sensations, and the process of attention is regarded as often determining between the *motifs* to localisation and those to eccentric projection. The two mutually opposing views are: (1) The system of muscular sensations of movement and the system of visual sensations are thought to combine to develop our perceptions of objective space in its three dimensions; the sensations of touch being subsequently projected into a space thus originally constituted by combined muscular sensations and visual sensations. The eye and hand in motion are, therefore, thought to project their extended objects into a space which they develop themselves; while the ear and the nose project their perceptions into a space which they are compelled to assume on the authority of the other senses (Ladd). (2) In opposition to this view, we are more inclined to believe, with James, that the objectivity with which each of our sensations originally comes to us is not, in the first instance, relative to any other sensation. That is to say, our perception of space is *primarily* one of vastness; the spatial relations themselves are *secondarily* determined by a process of analysis, and this by the activities of our muscular and visual senses. When we speak of hallucinations and the various perversions of the sense of movement, we shall see that we almost constantly regard the seat of stimulation as the seat of sensation also. This tendency is the natural outcome of our habitual reference to sensations as exoneural. In our ordinary waking moments we regard many of our sensations as external realities; others we regard as merely the mental counterparts or imaginings of physically-occasioned sensations. In reality, of course, the sensation is in both cases the psychical equivalent of cerebral effects, either peripherally or centrally determined. In dream states, and in artificially induced hypnosis, however, the hallucinatory intensification of the exoneural reference of sensations is often morbidly exaggerated. Similarly, in the insane, passing ideas may acquire hallucinatory strength, and there is failure to recognise their true objective import. We shall have occasion, however, to return to these considerations, so we now pass to the question as to how the various actual presentations of sense are elaborated by the mind itself.

Spatial discrimination is dependent upon—

1. Certain conditions of the sense-spaces—*i.e.*, each space

must contain its special local sign; two spaces which have the same local sign cannot be discriminated from each other. Unless these local sense-spaces are excited by external stimuli, there is little or no local difference of feeling.

2. Partial stimulation must be possible, otherwise no power of differentiation would be afforded to the sensitive surface. In order that a sensation may be aroused, the local differences must have their appropriate or specific *quale*.

3. There must be sensations of active or passive motion. In passive motion the sensibility of the joints is one of the essential factors in determining the sensation; whilst in active motion sensations of position are of great importance. Our sense of movement is much more delicate than our sense of position, and the important part that the former sense plays in our perceptive activity has given rise to the opinion that the muscular sense is the primary source of all our space-perceptions.

4. The sense-spaces must be measured against each other—*i.e.*, the experiences of one sensory surface must be compared and corrected, if necessary, by comparison with the experience of other sensory surfaces. In this way a comparison of spatial surfaces or extent is obtained. When we are not able to estimate the dimensions of an object by the superposition of one surface upon another, or by the superposition of one thing upon many surfaces, we naturally fall into erroneous or illusory assumptions.

5. The mind must be able to interpret the different sense experiences. The mind experiences a sensation through the instrumentality of the local sign. With the interpretation of the objective causality of the local sign, data from other senses enter into serial relation. The act of attention to the several data thus presented in a definite and relative order favours the tendency of these data to be located together, so that ultimately their several locations tend to merge into one location, and are apprehended as one extent, yielding on analysis its several data.* This tendency to form serial or intimately connected sense-data perceptions, is, in great part, the apparent physiological basis of what has been termed intuitive perception.

* Prof. James, "Principles of Psychology," vol. ii. p. 182.

When sense-data originate from stimuli affecting two or more points of the same sense-organ, the resulting sensations are arranged imaginatively in an exoneural serial order. The mind apprehends first one sensation then another, and the image of their spatial relations is thus analysed by the mind. The mind itself does not attend to the several local signs simultaneously, and with an equal amount of intensity. First one is attended to, then another, and the relative series forms a more or less indistinct perceptual image. Thus it would appear that the intuition of space is, primarily, one of vastness; the spatial relations of stimuli, affecting the various spaces of the same sense-organ, being determined by an analytic or serial process.

Special Channels of Perception.—We have already seen that the senses of touch and sight differ from the other senses in their greater power of local discrimination. These senses only give us knowledge of the primary qualities of objects. By their activities we obtain our empirical knowledge of space; space qualities of objects; knowledge of figure, size, and mechanical or force properties. This knowledge is of more importance to us than that gained from the other senses. In order to complete our account of the synthesis of simple sensations we must devote some attention to the presentations ot sense which come through the special senses.

1. *Perceptions of smell and taste* differ in fineness, duration, and accompanying tone of feeling. The pure perceptions of these sense-organs possess little or no spatial value. Taste involves an element of touch and muscular sensation.

2. *Perceptions of hearing.*—Sensations of sound are localised only through complicated indirect inferences. Those abnormal sensations which are localised as originating within the ear, or in the physical apparatus near to the ear, are termed "*entotic*." Subsequently we shall see that these entotic sensations are often misinterpreted by the insane. In some instances, the power to distinguish between entotic sounds and those having external origin is almost entirely lost. Whether a distinct spatial contiguity in the arrangement of several tones heard at the same time is ever developed is open to discussion. Some authors hold, that the favourable condition for the development of the spatial character of our sensations is to be found in the

simultaneous existence of several sensations alike in quality. This, however, would appear to be only in part true. As we have already seen, the existence of several acoustic sensations alike in quality would depend upon the existence of several tones corresponding to the number of vibrations of the sound-wave per second, and the combination of like tones would only increase the mass of the sound-waves, and thereby cause an increase in the intensity of the acoustic sensation. Sensations of sound vary in quality, and it is by this very difference in quality that the musician is able to refer to the spatial relations of the component parts of chords.

Undoubtedly, we do not find sufficient explanation of the spatial relations of sound in the highly-differentiated characters of the auditory fibres, and their adaptation to the numerous qualities of sound; nor do we get much aid from the elements of touch or muscular sensibility. We can form a rough estimate of the direction or distance of a sound by the adaptive movements of the head. Some authors believe that an approximate judgment is possible, owing to slight concomitant sensations of touch on the skin, appearing in different localities, according to the direction of the sound produced by delicate sympathetic vibrations of the hairs in the concha, and possibly, also, by vibration of the bones (cranio-tympanal conduction). The estimation of the spatial relations of several combined acoustic stimuli is largely aided by the sensations of sight. Some musicians relegate the component parts of a common chord to their visual series of intervals or spaces. With them, the varying qualities of tones, of a major or minor chord, or even the series of tones of a melody, are projected into visual space. Thus, in the analysis of musical sounds, reference is made to these visual spatial relations, the knowledge of which has been gained by experience. The spatial relations of sound would, therefore, appear to be mainly determined by secondary associative processes.

Usually, the localisation of sound is thought to be explained mainly by reference to the data derived from sensations of touch and sight. It is necessary, however, that we should take some account of other factors which have been regarded as essential. There are two opposing theories of sound-localisation.

I. (*a*) Auditory sensations in the right and left ear are different, and this original difference is the foundation upon which, by means of association, the whole localisation is built up (Stumpf). (*b*) Sound-stimuli arouse special space-sensations in the semicircular canals. The nerves of the canals act like a sense-organ, which is stimulated in various portions when the stimulus enters from different directions (Preyer). (*c*) The localisation depends upon a judgment of the difference of the intensities received by the two ears (v. Kries, Bloch). (*d*) Sensations of touch in the shell and drum of the ear assist in the localisation.

II. In opposition to these theories Münsterberg* upholds the view, that the assigning of direction to sounds rests upon the union of sensations of sound and sensations of movement, the latter originating from actual or intended movements of the head in the direction of the sounding body. The objection has been raised by v. Kries, Stumpf, and others, that, if we localise a tone by uniting it with a sensation of movement, how is it that we are able to localise two different tones that are strictly simultaneous? This difficulty must arise with every single instance of association. Two sensations of colour may arise simultaneously within the field of vision, but the perception of the qualities of the two sensations is not necessarily also simultaneous. The perceptive process is essentially analytic, and the attributes of the object presented are viewed *seriatim.* Münsterberg grants that the objections of v. Kries and Stumpf point to a universal defect in the usual psychophysical theories. This defect, we believe, is due to the misconception that because two sensations may arise within the same field simultaneously, therefore the perception of the qualities of the sensations must also be simultaneous. Preyer's theory is untenable both physically and physiologically.

From the experiments of Münsterberg and Pierce, conducted at the Harvard psychological laboratory, it was found that a conscious relation of tones to either of the ears does not exist; that sensations of touch play no essential rôle; and that we are not justified in speaking of the difference of intensities in the two ears. Many things go to show that the accom-

* "Beiträge," H. ii. § 182.

panying sensations of movement are to be regarded as the psychological basis of auditory spatial relations. The results of the various rotation experiments indicated, that the localisation depended upon sensations of movement, and not upon the comparison of auditory intensities. Further, the localisation was independent of any misplacements in the visual field.*

3. *Perceptions of touch.*—The most important factor in the perception of touch is the "*sense of locality.*" Weber measured the fineness of this sense, in regard to the skin, by ascertaining the minimum distance at which two points could be perceived as distinct in different localities of the surface of the body. The so-called "*sensation circles*" are those areas within which the minimum distances of the dividers' points are distinguished as two points. These areas are in reality elliptical, and have their major axis extending down the limb. They decrease in size as we pass from the trunk to the periphery of the limbs, and this depends mainly upon the facility of the parts for exercise. By practice this discriminative ability can be considerably increased. Within the circles two sensations can only be discriminated as one. Sometimes two points are only felt as one when the pressure spots stimulated are separated from each other by other pressure spots. This fact seems to indicate that, in addition to the local signs, accompanying ideas of motion play an important part in determining the ability for localisation. The distinction of neighbouring sensations from one another is held to be only possible by means of local signs and ideas of motion. To account for the "sensation circles" of the skin many theories have been advanced. These are :—

(1.) Each circle has only one nerve-fibre, whose terminal expansion covers the circle, and whose excitation is represented in consciousness by a sensation of a special value.

(2.) Each circle contains a number of pressure spots, and each pressure spot has a sensory fibre. Each point within the circle is itself sensitive, and the limits of none of the circles are fixed as would be the expanse of a single nerve-fibre distributed over them (Goldschneider).

(3.) Each circle contains a number of isolated nerve-fibres,

* "Psychological Review," September, 1894, p. 475.

and in order to produce the impression of two localised sensations, several unexcited fibres must exist between the two excited. The number of these unexcited fibres serves the mind as a kind of means for the approximate measurement of distances on the skin (Weber).

(4.) The circles represent the local difference between the points at which a stimulus must be applied to the skin, in order to produce enough of difference in the colour-tone of the resulting sensations to make them observable by the mind (Wundt).

Under tactual perception we are able to determine—(1) The weight, hardness, or smoothness of a material object. (2) The position of points both in our own organism, and in external bodies (size and figure). (3) The situation of objects through movement—(*a*) changes in velocity of movement, (*b*) reversing movements, (*c*) repetition of movements. (4) The size and form of objects through movement. Tactual perception proper is acquired by movement, and there is interpretation of the local characters of sensations by movement. (5) The simultaneous perception of points. The tactual perception of space is a product of two factors, movement and muscular sensation, and a plurality of sensations of contact. (6) The solidity of an object. (7) The discrimination of single things, and of a number. (8) The perception of moving objects (under this must be distinguished the difference between objective and subjective movement). (9) The sensations of temperature. (Our sensations of temperature vary according to the temperature of the subject.) Our space, however, will not permit us to enter into the numerous details of these relations. We must content ourselves with a few remarks upon the discrimination of the amount and direction of motion in contact with the body.

The discriminative sensibility of the skin is much greater for motion than for touch, and this power of discrimination varies with different parts of the skin. Stanley Hall found that these differences do not completely correspond to the differences met with in the sensation-circles. The fact that our sensibility to motion is so much greater in each area of the skin than our susceptibility to the distance of stationary points, is held to accord with the theory of local signs, and it is thought that our ability to localise the dermal sensations is dependent upon the degree and rate of the *changes* in the colour-tone of these sensations. Other facts of importance, derived from the experiments of Stanley Hall, may be briefly mentioned. We are more likely, when in doubt, to judge motion on the surface of the limbs to be up rather than down their axis; on the breast, the shoulder-blades, and the back, the tendency is to judge motion to be toward the head. The rate of movement causes variations: thus, a very rapid movement may appear to be shortened, or a very slow movement may not be discriminated at all. Heavy weights seem to move faster than light ones going on at the same rate; but here other sensations are called out by the deep pressure, combined with those of contact.*

4. *The perception of muscular sensations.*—The chief theories to account for the so-called muscular sensations have already been given. The theory that these sensations are specific sensations, dependent on a specific nerve-apparatus of sense, which has its end-organs in the muscle-fibre, finds the most favour. It is doubtful, however, whether the muscular sensations do differ qualitatively. They may have a different colour-tone, and act like local signs; but the muscular sensations alone do not afford us sufficient data to account for our perceptions of spatial qualities and relations. In addition to the muscular sensations the tactual discriminative element is essential for the perception of spatial relations. Several writers uphold the view, that all spatial measurement arises primarily from the perception of muscular movement.

Professor James believes that no evidence of muscular-measurements exists; but that all the facts may be explained by surface-sensibility, provided we take the joint surfaces also into account. Goldschneider goes further, and believes that the joint-surfaces alone are the starting points of sensations by which the movements of our limbs are perceived. From an analysis of the experiments of Goldschneider and Lewinski, it would appear, however, that the joint-feeling is not the sole source of spatial perception of movement. The absolute space-

* Ladd, "Phys. Psych.," p. 411.

value is derived from secondary suggestive influences brought about by associated tactual and visual perceptions. Professor James says, "The joint-feeling can excellently serve as a map on a reduced scale, of a reality which the imagination can identify at its pleasure with this or that sensible extension simultaneously known in some other way." The muscular sensations in themselves give us knowledge of spatial relations only in an indirect way by the effects of muscular contraction upon the surfaces of the skin and joints. Spatial discrimination would, therefore, appear to be related to the effects of movements upon these surfaces, and the secondary suggestions of visual imagination. James accounts for the phenomenon of eccentric projection by the localisation of the joint-feeling in a space simultaneously recognised from other sources—*i.e.*, through the skin or the eye.

5. *The perception of visual space.*—In the perception of smell, taste, touch, and hearing, we have seen that there is usually a corresponding visual presentation. According to the Berkeleian theory the visual sense derives much of its knowledge of external things from touch. The local discriminative sensibility of the retina is insufficient by itself to determine spatial relations. Volkmann* gives eight different data which are used in monocular vision for perceiving the third dimension of space and of visual objects in space—viz., *monocular vision.* (1) Extent; (2) clearness, of the complex of the sensations of colour and light, as dependent on distance; (3) the perspective elevation of the bottom of distant objects above the horizon; (4) the covering of known distant objects by those placed nearer; (5) the alterations of light and shadow on the curved surfaces of the object, according as they are nearer or more remote; (6) the perspective contraction of the retinal image; (7) the change of the visor angle in proportion to the distance of the object; (8) the muscular sensations of the accommodation of the eye.

To these data Ladd† adds two others for binocular vision—viz., (9) the stereoscopic double images; (10) the sensations arising from convergence of the axes. The question has been

* "Lehrb. d. Psychologie," ii. p. 84.

† "Phys. Psych.," p. 421.

raised whether tactual sensations which accompany the movements of the eyeballs in their sockets do not possess some spatial value. The local *quale* of the retinal signs has already been referred to.

In an act of visual perception certain data are essential. There must be sensations of light and colour simultaneously present in consciousness. The subsequent perception of their spatial relations only becomes possible with the help of retinal signs, and the series of sensations derived from the movements of accommodation. Lipps, Wundt, Münsterberg, and others, share this view of the importance of eye-movements, and the sense of their position in determining a spatial series. Volkmann, Hering, Helmholtz, Goldschneider, James, and others, on the other hand, believe that eye-muscle contractions have only a feeble share in determining sensations of the third dimension. For our part, we believe, that the purely muscular sensory element plays quite a subordinate part to that of the tactual and retinal elements in the estimation of space.

Wundt* says, there are three things to be determined in explaining perceptions of sight: (1) the retinal image of the eye at rest, and the *motifs* which it furnishes; (2) the single eye as moved, and the influence of these movements; (3) the conditions furnished by the existence and relations of the two eyes exercising their function in common. We have, therefore, to consider the retinal field of vision, and the fields of monocular and binocular vision.

The problem of the physiological process, which underlies the perception of distance, has occupied the attention of many psychologists. Helmholtz and Wundt affirm, that the organic eye-process pure and simple, without the aid of other sense data, cannot give us any sensation of a spatial kind at all. That it does not depend upon the combination of images through binocular vision, is proved by the fact that one-eyed people have it. Nor can it be explained by convergence or accommodation feelings. Lipps concludes that our knowledge of the third dimension must needs be conceptual, and not sensational or visually intuitive. Stumpf thinks that the primitive sensation of distance must have an immediate physical ante-

* "Physiolog. Psychologie," ii. p. 62.

cedent, either in the shape of an organic alteration accompanying the process of accommodation, or else given directly in the specific energy of the optic nerve. He also thinks that it is the absolute distance of the spot fixated which is thus primitively, immediately, and physiologically given, and not the relative distances of other things about this spot. James believes the neural process is to be found in the number of retinal elements affected by the light; but that in the case of "protension" or mere farness, it is more complicated, and is still to seek. He says, "The two sensible qualities unite in the primitive visual bigness. The measurement of their various amounts against each other obeys the general laws of all such measurements. We discover their equivalencies by means of objects, apply the same units to both, and translate them into each other so habitually, that at last they get to seem to us even quite similar in kind. This final appearance of homogeneity may perhaps be facilitated by the fact that in binocular vision two points situated on the prolongation of the optical axis of *one* of the eyes, so that the near one hides the far one, are by the other eye seen laterally apart."

When we come to consider the various illusions of the senses, we shall return to the view of James, that every spatial determination of things is originally given in the shape of a sensation of the eyes. He sums up his theory in the statement that "measurement implies a stuff to measure; retinal sensations give the stuff; objective things form the yard-stick; motion does the measuring operation." The numberless investigations and discussions which have been brought to bear upon the question of binocular vision, and to explain how it is that a double retinal image is only perceived as one, cannot occupy our attention here; nor can we afford space to elaborate the theories as to how vision receives its stereometric character by association with ideas of motion and touch. The law of Weber is only valid in the case of sight for medium distances in the estimate of magnitudes of extension. It remains for us now to recognise the relationship of the data presented to us in the attempt we have made to explain perception.

We have seen that these data depend upon external stimuli, and we have assumed the existence of specific and qualitatively-different functional nerve-elements, by the instrumentality of which, either separately or in combination with each other, these data are presented to the psychical subject. Our efforts, however, have ended in a mere enumeration of data and their possible laws of analysis and synthesis.

The influence of the retinal field of vision in determining spatial perception has already occupied our attention. We do not hold, that the retinal field, when its mosaic of nervous elements is stimulated, alone can determine a spatial series; nor do we believe that sensations of light and colour would have space-form if they only came from an excited but motionless retina without being combined with other sensations of a spatial series; we merely assume, that spatial perception, at least in a germinal form, is native to the mind by reason of the *quale* of the retinal elements, and that the fully-developed perception of spatial quality cannot be *entirely* explained by tactual or so-called muscular sensations of movement—*i.e*, we assume that there is a native content of vastness, and that the spatial relations of the integral parts of the vastness are perceived by a process of analysis effected partly through the sensations of movement. We cannot enter into the question of the law which governs all the movements of the eye. We must, however, note the general law, as given by Ladd, that "the construction of the field of monocular or binocular vision is a synthetic mental achievement, dependent upon the varying sensations, which results from the wandering of the point of regard over the outline of an object."

This view, as we have just seen, is open to criticism, and we hold that the field of vision in its entire content is one primarily of vastness, and that the perception of the component parts of that field is an analytical mental achievement, depending upon the varying sensations which result from the wandering of the point of regard over the contents of the field of vision. That is to say, our perception of objective space, in its vaster extents, is originally constituted; the subsequent perception of its spatial contents is secondarily analysed.

CHAPTER VIII.

Sensory Perversions.

The Origin and Development of Sensory Perversions—Abnormal Conditions of Perception—Definition of Illusion—Sources of Illusion — Classification — Passive Illusions — Exoneural — Esoneural — Active Illusions—Voluntary—Involuntary.

Secondary Sensations — Sound Photisms — Light Phonisms — Taste Photisms — Odour Photisms — Pain Photisms—Chromatisms—Gustatisms—Olfactisms—Laws concerning Secondary Sensations.

The Origin and Development of Sensory Perversions. — In the consideration of illusory phenomena it is necessary to remember that the perception of sense-data derived from the finer senses is more readily revivable under abnormal conditions than the perception of those sense-data derived from the less refined senses. The development of perceptual power involves an increasing power of sense-discrimination, and also an increasing power of identifying impressions through the "cumulation of traces." That is to say, our senses become more acute in distinguishing impressions by means of their local signs, and the mind becomes quicker and keener in identifying them.

The sense-capacity varies in different individuals in its absolute sensibility and in its discriminative power. A general discriminative power probably implies, from the first, a fine organisation or nativistic power of the brain as a whole; whereas, a special discriminate sensibility implies rather an original structural excellence of the particular sense-organ concerned. The prominent part taken by the visual sense in the development of perception as a whole has been already mentioned. Complete development of the perceptual power involves (*a*) sense-perceptions in their various degrees of perfection; (*b*) daily-renewed conjunctions of simple sense-experiences—*e.g.*, between touch and sight; (*c*) noting nature of objects as such and recognising them; (*d*) after this the growth of perception is mainly due to an improvement of visual capacity, or increase in visual discrimination; and (*e*) development of the power of attention, which, however, is, to a certain extent, pre-supposed.

Our knowledge of external things depends upon the training of our perceptual power. Unless we have cultivated the practice of accurately discriminating the forms of things all our after knowledge will be inaccurate. We must not only treat the forms of concrete objects from an analytical, but also from a synthetical point of view—*i.e.*, the analytic and synthetic treatment of the forms of objects should be equally cultivated.

The blind man is able to construct perceptions of space quite independently of a visual sense. He is conscious of a horizon, and can appreciate arrangement and dimensions. By a synthetical process he can summarise in his imagination a fairly accurate estimate of the spatial relations of objects. The absence of this sense need in no way interfere with the development of a full and powerful intellect. What the psychology of a blind man's spatial perceptive power is can only be explained by the assumption that there is a nativistic power within the mind itself, which can assert itself with freedom apart from the direct influence of the visual sense.

Abnormal Conditions of Perception may, for convenience, be described as they occur:

(1) In the sane.

(2) In intermediate states between sanity and insanity.

(3) In the insane.

A false perception is technically called an illusion, and it must be borne in mind that the process is often largely the same in a false perception as in a true one. Some authors would seek the explanation of the fallacy in an illusion, by taking into account the action of the senses only, and they would assume the mental interpretation of the false sensory impression to be the abstract result of a fallacy of the senses.

We have already discussed the law of the specific energy of nerves, and we have spoken of adequate (or homologous) stimuli. We have also briefly referred to stimuli (heterologous) which act upon the nervous elements of the sensory apparatus along the entire course from the end-organ to the cortex cerebri. These latter stimuli, when of internal somatic origin, give rise to subjective mental phenomena of varying degrees of quality and intensity.

In the *sane* person there is a constant liability to errors of perception. Illusions are common to us all. Our discriminative power is necessarily limited and defective. Thus the study of sensory perversions belongs both to the psychologist and to the mental pathologist. There is no sudden break between the illusions of the sane and those of the insane, and there is often great difficulty in distinguishing between them. Our judgments are liable to be distorted at any time, and our sensory discriminations may be at variance. Any emotional disturbance, any state of exhaustion, inattention, expectancy, or mental preparedness, may favour the development of some false sensory perception. The transition from sane to insane perceptions is often difficult to demonstrate.

In the *intermediate* conditions, half-way conditions between sanity and insanity, we have many examples of sensory disturbances. Thus in some dream-states, night-mare, religious fanaticism, and many excessive emotional states, we have perversions which are suggestive of a neurosis rather than true nerve health. In hysterical temperaments, especially, do we find illusory morbid conditions. In the sane, the illusory percepts may be due to defective knowledge; or the illusory nature of the percepts may be recognised by the individuals in whom they occur as the results of defective energisation. In the intermediate states there is often failure to recognise the true nature of the illusory phenomena at the time of their occurrence, but this knowledge may be gained at some subsequent period.

In the *insane* there is not only a failure to recognise the true nature of the phenomena, but also a belief in their objective reality, and, as a consequence, there is a tendency on the part of the individual in whom they occur to act upon the false evidence presented to the mind by way of the senses.

Definitions of Illusion.—In order that we may fully comprehend the meaning of an illusion, we must take account of its factors from several points of view To define it as a false sensory perception is insufficient. There is a standard of falseness, and one must remember that human experience is fairly consistent. Our perceptions and beliefs fall into a consensus. Some metaphysicians hold the idealistic view, that perception itself is an illusion, inasmuch as it involves the fiction of a real thing independent of the mind, yet somehow present to it in the act of sense-perception. With this question, however, we have nothing to do.

An illusion is further defined as a "mistaken identity"—*i.e.*, a partial displacement of an external fact by a fiction of the imagination. Another definition is, that an illusion is a false percept which arises in the mind of an individual under circumstances which would not give rise to similar percepts in the case of other people. This is still, however, inadequate. There are special circumstances which are fitted to excite a momentary illusion in all minds—*e.g.*, optical illusions may be due to refraction of light, reflection, etc., and these may arise in all minds under precisely similar circumstances. Any definition must be relative. The false percept must be one that can be contradicted by a more accurate percept; or, as Sully puts it, it is a deviation from the common or collective experience. This deviation, as met with in the insane, is a species of perceptual error, which is peculiar to the individual, and, as we shall see later, it involves not only present sense-data but also other psychical factors.

The **sources** of illusions of perception are: (1) Suitable soil; a neurotic type, or physical preparedness, due to inheritance or disease. (2) Expectancy; a mental preparedness is the most prominent factor in the causation of so-called "active" illusions. (3) Inattention or incomplete attention to the sense presentation. Closely allied to this is (4) confusion of sense-impression. In the regions of hazy impression, or of diffuse consciousness, illusions are most apt to occur, and play the greatest pranks. Every cricketer appreciates the difficulty, or confusion of sense-impression, that is apt to arise when there is any movement in the field behind the bowler's arm. In the same way, the presence of a swallow on the cricket field, as viewed by the retinal points outside the field of central focus, is apt to give a confused impression of a ball moving in space. Organic sensations, occurring in the regions of sub-consciousness in both sleeping and waking moments or between them, give rise to illusions. (5) In mental states, which are the result of habits of inaccurate discrimination—*i.e.*, in mental states built upon data which have not been analysed—the interpretation of the present sense-impression is apt to follow the law of habit, and the habit of loose inference, or misinterpretation of sense-impressions, may result in the acquisition of so-called unconscious fallacious inferences, and fallacious conclusions from present determining sense-data.

Varieties of Illusions of Perception.—These have been arranged according as they arise from *without*, by suggestion of external or physical factors; or, as they arise from *within*, due to the development of preperception, or the element of expectancy. The former have been termed *passive* illusions, the latter *active*. The factors of causation may be grouped in the following order:—*

PASSIVE ILLUSIONS.

1. **Exoneural,** determined by—
   - (*a*) Exceptional external arrangements.
   - (*b*) Exceptional relation of stimulus to organ.
   - (*c*) Illusions of art.
   - (*d*) The particular forms of objects.
   - (*e*) The points of similarity of objects.
   - (*f*) The reverse illusions of orientation.
2. **Esoneural,** determined by—
   - (*a*) *The limits of sensibility:*

Degree of stimulus.	After sensations.
Number of stimuli.	Specific energy of nerves.
Fusion of stimuli.	Eccentric projection.

* See Sully's "Illusions."

(*b*) *By the variations in sensibility;*

(1) *Momentary*, or transient, caused by fatigue, malnutrition, or toxic agents.

(2) *Permanent*, caused by variations in excitability of sensory organs, hereditary or acquired. In conditions of hyperæsthesia, anæsthesia, and paræsthesia.

ACTIVE ILLUSIONS,

which involve the element of expectancy:—

1. Voluntary selection of interpretation.
2. Involuntary mental pre-adjustment.

(*a*) *Temporary expectation or preparedness:*
Sub-expectation.
Vivid expectation.

both of which may arise from—
Present objective facts.
Verbal suggestion.
Imagination.

(*b*) *Comparatively permanent disposition,*
as seen in the evolution of conceit, hypochondriasis, etc.

In the account of all these states, it must be remembered, that every function is rendered more facile by exercise, and that illusions become more real by repetition.

Passive Illusions determined by environment—

1. *Exceptional external arrangements.*—The ordinary physical phenomena of the refraction of light and the reflection of sound. A stick half-immersed in water appears to be bent. The optical illusions of magnitude, due to external conditions, are numerous and well known. The atmosphere has to account for various illusions as to distance. Thus, the person unused to the clear atmosphere of Switzerland is unable to realise distances. At times, great difficulty is experienced in deter-

mining whether our train or the one alongside it is moving. When we move forward all objects appear to glide backwards. The faster we go, the nearer do the objects seem, and the nearer they seem, the smaller do they look. This fact is explained by the greater rapidity of their apparent translocation (Helmholtz).

2. *Exceptional relationship of stimulus to organ.*—Aristotle's experiment, of crossing two fingers of the same hand and rolling a pea between them, is attended by the illusion of there being two peas instead of one. Each of the two points of contact has its local sign; but, from their inexperience of working in unison under certain particular conditions, there is distortion of the inference. In a similar way the experience of having "sea-legs" on land is to be explained by the absence of the accustomed undulations of the structure on which we walk, and the want of the customary tactual and surface sensation experiences. The examples given by Sully afford further illustration. When a man crunches a biscuit, the sound is intensified owing to the propagation of the stimulus by other channels than the usual one of the ear. If the two hands are bent into a sort of auricle, and placed in front of the ears, the back of the hand being in front, the sense of direction, as well as of distance, is confused. Thus, sounds really travelling from a point in front of the head will appear to come from behind it. Objects appear smaller and at a greater distance when one eye is used than when both are used. Illusions of movement occur owing to our eyes moving without our knowing it. Perception of an object's movement depends upon the sense of movement in our own eyes. James regards the original visual feeling of movement as produced by an image passing over the retina. He says, "This sensation is definitely referred neither to the object nor to the eyes. Such definite reference grows up later, and obeys certain simple laws. We believe objects to move (1) whenever we get the retinal movement feeling, but think our eyes are still; and (2) whenever we think that our eyes move, but fail to get the retinal movement feeling. We believe objects to be still, on the contrary, (1) whenever we get the retinal movement feeling, but think our eyes are moving; and (2) whenever we neither think our eyes are moving, nor get the retinal movement feeling."

3. *Illusions of art.*—Pictorial art aims at stereoscopic effects, and seeks to give to flat surfaces the illusory effect of depth, relief, and solidity. By means of colour in various qualitative and quantitative degrees, an imitation of natural objects is sought. This imitation suggests to the mind the habitual interpretation of natural sense-impressions, and hence the imitative art is a source of complete illusory effects. The illusion that the eye in a portrait seems to follow the spectator is due to the fact that the surface of the portrait is flat, so that the profile of the object is never seen.

4. *Misinterpretation of form and local arrangement.*—This is clearly allied to the foregoing illusions of art. An object appears smaller on the lateral portions of the retina than it does on the fovea. The intensity of the nerve-excitation sometimes increases the volume of the sensation as well as its vividness. Professor James* gives the following instances of these illusions: "If we raise and lower the gas alternately, the whole room, and all the objects in it, seem alternately to enlarge and contract. If we cover half a page of small print with grey glass, the print seen through the glass appears decidedly smaller than that seen outside of it, and the darker the glass the greater the difference. When a circumscribed opacity in front of the retina keeps off part of the light from the portion which it covers, objects projected on that portion may seem but half as large as when their image falls outside of it (Classen). The inverse effect seems produced by certain drugs and anæsthetics—morphine, atropine, daturine, and cold, blunt the sensibility of the skin, so that distances upon it seem less. Haschish produces strange perversions of the general sensibility. Under its influence one's body may seem either enormously enlarged or strangely contracted. Sometimes a single member will alter its proportion to the rest; or one's back, for instance, will appear entirely absent, as if one were hollow behind. Objects comparatively near will recede to a vast distance; a short street assumes to the eye an immeasurable perspective. Ether and chloroform occasionally produce not wholly dissimilar results."

To attempt to give an account of all the ambiguities of

* "Principles of Psychology," vol. ii. p. 142.

retinal impressions, and the part they play in misinterpretations of the form and arrangement of external objects, would involve too much time and space. Nor can we enter upon the question of the ambiguous import of eye-movements, and the interpretations of the feelings of convergence and accommodation. For an account of the ambiguities which result from the perception of lines meeting and crossing each other on a plane, the student must refer to the various text-books on physiological psychology. Here we can only present a brief summary of the phenomena. The law of habit has most to do with the illusions in connection with diagrams on planes. We are apt to view the object in its habitual form —*i.e.*, when we look at a portrait our imagination suggests that the object occupies space in its three dimensions. The actual retinal image suggests the memory of the image in its stereotyped form. The vividness of the reproductive processes is regarded as greatest when the visual sense is involved.

The movements of the eye aid in the education of our perceptual power; but every spatial determination is primarily given in the shape of a sensation of the retinal elements of the eye. The remarks which apply to space-perception apply equally well to colour-perception. Professor James believes, that present excitements and after effects of former excitements may alter the result of processes occurring simultaneously at a distance from them in the retina or other portions of the apparatus for optical sensation, and that the spurious account of these illusions is that they are intellectual, not sensational; that they are secondary, not primary, mental facts. That is to say, the various illusions as to form and arrangement are mental facts suggested by present objective facts; but, in their fully developed states, they are due to an imaginary reproduction of habitual and real forms, suggested by the present objective facts.

5. *Illusions arising through similarity in objects.*—Every one is familiar with the fact that he is apt to make mistakes in identifying persons and things. The process is similar to that just described. The suggestion of a familiar object, made from without, involves the reproduction of an old and habitual perceptual process. The familiar interpretation acquired by

practice becomes superimposed upon the present percept, with a vividness which tends to obliterate or submerge the subjective perception of the actual object as it exists. In dream-states, and in the insane, one finds innumerable examples. Some insane persons perceive objects or persons so imperfectly that the actual presentation at the time is immediately submerged by the vividness of the image of recalled familiar objects or friends, and they are immediately imagined to be those familiar objects or friends. The process is a mental one. From a physiological point of view it may be urged that the actual and immediate perception is distorted by a disordered nerve-tract, and that the misinterpretation is the primary result of such distortion. The answer to this is simple. We have already seen that the element of association is involved in every percept, and that the interpretation of a sense-presentation is to a large extent dependent upon comparison with former presentations. A typical illusion is a secondary product; the initial stimulation by a sense-presentation suggests to the mind a representation of more definite organisation, which takes the place of the initial presentation.

6. *Reverse illusions of orientation* have been fully described by Binet.* These illusions may arise spontaneously, either when we awaken in the darkness of night, or during the day when awake. They consist in any illusory experience that a wrong direction is being taken; that objects are reversed from side to side; or that the individual is turned round. Beaunis, Passy, Henri, Philippe, Courtier, Thélohan, and others, have described these illusions as part of their own experiences. The author of this work invariably fails to orientate himself on arrival at a certain railway station, and this although he has visited the station weekly for more than six years. Binet distinguishes three kinds of cases: (1) Normal orientation, in which the points of reference recognised confirm the former sense of direction; (2) disorientation, in which there is no sense of direction at all, and if a familiar point of reference is met with, it is accepted, and the individual orientates himself properly; (3) inexact orientation, in which an individual meets a point of reference, but finds it in contradiction with his

* "Le Renversement de l'Orientation."

earlier system; the false system persists, even though it is known to be false, just as an illusion persists. Binet suggests that possibly the illusion may be produced by a particular derangement of the semicircular canal of the inner ear.* This, however, is a possibility we are unwilling to admit.

Passive Illusions determined by the Organism—

1. *By the limits of sensibility:*

(*a*) *Degree of stimulus.*—We have already discussed the various limitations in discriminative power of the different senses, and we have seen, that below the point of liminal intensity, and beyond the point of maximum intensity, our perception of stimuli is imperfect or non-existent. This perception of degree also is altered considerably in mental diseases. Thus, there may be defect of discriminative power when the attention of the individual is focussed upon some mental idea or hallucination; or, as in some cases of stupor, the senses are abnormally slow in their action. In some maniacal conditions, on the other hand, there may be an unusually fine degree and rapidity of discrimination. Again, among stimuli arising from without there is always a struggle for supremacy within. There is a survival of the fittest and most interesting within the focus of attention; the remainder lie within the field of diffuse consciousness or outside it altogether.

(*b*) *Number of stimuli.*—The difficulties met with in the interpretation of local signs have already been considered. The case of two points recognised as one only, owing to character and amount of the interval between them, has also been alluded to.

(*c*) *Fusion of stimuli.*—The retinas are acted upon separately, and the resulting impressions become fused into one. How the mind perceives but one object, or how the coalescence occurs, we do not know. Illusions may result from imperfect coalescence of images. When double images are seen, although there may be sets of retinal fibres so organised as to give an impression of two separate spots, yet the excitement of other retinal fibres may inhibit the effect of the first excitement, and

* M. Vignier, "The Sense of Orientation and its Organ in Animals and Men," Rev. Phil., July, 1882. Binet, "Vertigo of Direction," Mind, 1884. M. Flournoy, "Les Synopsies," p. 188.

prevent us from actually making the discrimination (Volkmann). Still further, retinal processes may bring the doubleness to the eye of attention; and, once there, it is as genuine a sensation as any that our life affords (James).

(*d*) *After sensations.*—When a clock strikes we sometimes experience the illusion that a stroke has occurred after the sounds have actually ceased. Discontinuous stimulations rapidly following one another appear to be continuous. After a bandage has been removed from the head the sensation is still continued. The tasting of sherry and port alternately, results in inability to distinguish between them. The sensations of the rolling of a ship may remain for days. The sensations of movement after a bicycle ride may continue to assert themselves even during sleep.

(*e*) *Specific energy of nerves.*—The perception of light (phosphenes), when the eyeball is pressed, is illusory, inasmuch as we refer the presentation to light. In the insane we occasionally see morbid instances of this nature. Thus, stimulation of the various nerves, having their characteristic local colourings, is followed by misinterpretations of the actual physical agencies at work which cause the presentations; the direction of the attention being determined by the character of the stimulus and the local specific and suggestive energy of the nerves. The interpretation afforded by the mind, when the attention is focussed upon the presentation, is determined by reference to former presentations, and by the mental complexion of the moment—that is to say, the imagination is an important factor. The actual presentation, as determined by the immediate stimulus, is vague and ill-defined; whereas, the secondary product, derived through association or expectancy, is often vivid and apparently real. A patient now in Bethlem Hospital has only to press his eyeball with the "stone of life" in order to open up to him a vision of "green fields and objects of wondrous beauty." In this case the primary presentation derived from pressure was that of light only; imagination did the rest. He now *expects* the vision, and *associates* its origin with mechanical means. The interpretation is fallacious, and he locates the apparent reality within the "stone of life" itself. In order to test the accuracy of this view, the stone was applied to the ear, with the result that simple "sea-shell" sounds were first experienced; then followed the element of expectancy, and imagination supplied in turn, sounds of whisperings, voices, hummings, music, etc. Now the "stone of life" provides him with the enjoyments of other associative phenomena.* The patient himself gives the following account of the phenomenon:—"When the stone is placed over the eye and kept there for some considerable time, the first impression of sparks of light gradually resolves itself, by a shimmering process, into a more definite representation of a luminous field with a more or less definite coast line, or sometimes a mountain line. Sometimes I see distinct trees, and figures of fantastic shapes moving about. The stone possesses this property within itself, because, without it, I see nothing. On placing it over the ear, the impressions previously produced by the eye become more clearly defined, and even when I press it on my forehead I see all the scenes just as vividly. I have at other times seen flowers and fruit trees, and on applying the stone to the nostrils, I have smelt the odours of the flowers; and, when the tongue was touched, the taste of the different kinds of fruit. In the case of my sight, I apply the stone first, and all the scenes appear to me; with the other senses, however, I see what the things are first, and the stone supplies me with the knowledge of their various qualities."

(*f*) *Eccentric projection.*—By the "law of eccentricity" physiologists affirm that we refer our sensations to the peripheral endings of the nerves concerned. In the case of the senses of smell, hearing, and sight, we are apt to overlook the bodily seat of the sensation and project the cause to some external object. In abnormal conditions of nerve-activity, stimulation of any other point than the peripheral terminations is followed by subjective sensations, which are referred to the peripheral end-organs associated with the nerve-point stimulated. Similarly, disorders of the cerebral structures may give rise to sensations which closely resemble hallucinations in their after effects. As an example, we may give the instance of illusions of feeling apparently arising from sensations in toes after the limb has been amputated. The exact seat of the

* The case is of long duration, and incurable.

stimulus or morbid process is difficult to determine. In the insane, ordinary presentations may be wrongly interpreted. Thus, gustatory sensations assume, with the mental complexion of the individual, the objective significance of poisons; subjective tactual sensations of electricity, numbness, feeling of wool, shrinking, expansion, dragging, tingling, pain, etc., are all projected externally in accordance with the customary interpretations of local signs; but, in addition, the mental complexion determines wrongly the relative import of the causal stimuli, and hence sometimes gives rise to the wildest illusions of torture and persecution.

2. *Determined by variations in sensibility:*

(1.) *Momentary or transient.*—Every one is subject to momentary illusions, due to exhaustion of the various organs of sense. The condition may arise from direct strain, or through malnutrition, or, more commonly still, through the administration of toxic agents. Variations in the organic state cause alterations in the strength and quality of the sense presentations.

(2.) *Comparatively permanent conditions.*—The sense-organ may be unusually sensitive, so that the sense-impressions gain in intensity of effect. There may be variations in the excitability of the retina, so that colours are raised from violet to red, etc., or *vice-versâ* as in the colour blind. In conditions of hyperæsthesia ordinary stimuli become intensified. In anæsthesia they become less intense. In paræsthesia there is a qualitative change in the effects of stimuli. In the insane every variety of these quantitative and qualitative changes in the presentations of sense may be observed.

Sully points out, that all these groups of illusions have one feature in common; they depend on the general mental law, that when we have to do with the infrequent, the unimportant, and therefore unattended to, and the unexceptional, we employ the ordinary, the familiar, and the well-known, as our standard. "Thus, whether we are dealing with sensations that fall below the ordinary limits of our mental experience, or with those which arise in some exceptional state of the organism, we carry the habits formed in the much wider region of average everyday perception with us. In a word, illusion in these cases always arises through what may, figuratively at least, be described as the application of a rule, valid for the majority of cases, to an exceptional case." In the next group which we have to consider, the mental element is predisposed to the formation of sense-illusions; imagination and expectant attention play an important part.

ACTIVE ILLUSIONS.

In active illusions there is a mental preparedness or anticipation for presentations. The mind acts independently of immediate external sense-impressions, and by a process of imagination conjures up various combinations of representations; the preponderance of the mental element thus tends to colour, modify, or submerge the actual determining presentation when it arrives in consciousness. Expectant attention may even lead to the illusory belief that an event takes place before it actually does. In the sane, the independent activity of the imagination may conjure up the image of a friend, and this very mental preparedness may result in illusions of identity. In other words, a vivid representation may favour a partial distortion of a presentation; or rather, a vivid representation, super-imposed upon an imperfectly discriminated presentation, may result in an illusory perception. Wundt found by experiment, that the exact moment at which a sense-impression is perceived depends on the amount of preparatory self-accommodation of attention.

Romanes * says, "If a sportsman, while shooting woodcock in cover, sees a bird about the size and colour of a woodcock get up and fly through the foliage, not having time to see more than that it is a bird of such a size and colour, he immediately supplies by inference the other qualities of a woodcock, and is afterwards disgusted to find that he has shot a thrush. I have done so myself, and could hardly believe that the thrush was the bird I had fired at, so complete was my mental supplement to my visual perception."

"As with game," says James, "so with enemies, ghosts, and the like. Anyone waiting in a dark place and expecting or fearing strongly a certain object will interpret any abrupt sensation to mean that object's

* "Mental Evolution in Animals."

presence. The boy playing 'I spy,' the criminal skulking from his pursuers, the superstitious person hurrying through the woods or past the churchyard at midnight, the man lost in the woods, the girl who tremulously has made an evening appointment with her swain, all are subject to illusions of sight and sound which make their hearts beat till they are dispelled. Twenty times a day the lover, perambulating the streets with his pre-occupied fancy, will think he perceives his idol's bonnet before him."

At séances, full scope is given to the imagination; the mind is prepared and expectant. In states of hypnotism and trance, suggestion plays a most important part. "This suggestibility is greater in the lower senses than in the higher" (Meyer). Helmholtz doubts this power of imagination to falsify present impressions of sense. In some cases among the insane, the pre-occupation of the mind by dominant beliefs, fears, persecutions, and morbid anticipations, gives such a powerful mental complexion or colouring to all immediate impressions of sense, that the process may be compared to the addition of one drop of clear fluid to the blackest of inks, the one drop of clear fluid representing the present impression, and the blackest of inks the mental saturation by morbid thought. The writer experienced the effects of anticipation some years ago. Having to give a hypodermic injection of morphia every three hours during the night for nearly a fortnight, the expectancy and mental preparedness to hear the night-bell, even during sleep, became so powerful, that after the patient had recovered and there was no occasion to administer the drug regularly, at the appointed intervals the illusion became so vivid that several journeys were made under the belief that the bell had actually sounded. Every one is familiar with what Dr. Savage calls the "lost button" condition of thought. The absence of a button is sufficient to occupy our attention so completely, that sooner or later we imagine all eyes are upon the defective spot. The individual who imagines he is suffering the tortures of Hell and is eternally damned, may see a devil in every one who enters his room. Similarly, the exalted general paralytic, whose horizon is bounded by untold wealth and beauty, sees in every object around him some marvellous charm or property. In the maniac who is persecuted, every trivial occurrence, insignificant in itself, is distorted into some sign bearing the stamp of the mental complexion of the moment. The hypochondriac colours every sensory impression with his mental fear of dissolution. The maniac and the melancholiac alike view all incoming impressions through their mentally-coloured glasses. To the former all is bright and fanciful; whilst to the latter all is dark and dismal.

1. **Voluntary Selection of Interpretation.** — It is possible, by a purely mental act of creative imagination, to

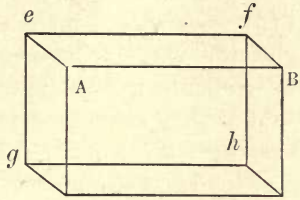

FIG. 14.

superimpose at will the image of the object imagined, upon some other actual objective image present. Thus, we can picture forms and images in clouds, etc.

In the diagram, either of the two large surfaces (A, B, C, D, or *e*, *f*, *g*, *h*,) may appear to be nearer than the other; or one surface may appear to face a point to our left and upwards, or to our right and downwards. Thus the two surfaces, far and near, may be transposed at will; or each may be regarded as facing two directions.

2. **Involuntary Mental Pre-adjustment.** — In the percipient mind, which is pre-adjusted to act in certain definite directions, this predisposition may evidence itself as a temporary state of expectation, or as a comparatively permanent condition.

(*a*) *Temporary expectation or preparedness.—Action of sub-expectation.* — Every one has experienced various illusory beliefs about objects and things. A certain amount of preparedness is necessary before witnessing a play. The imagination supplies the preliminary data or predisposition to accept the events of the stage as more or less real. Without such preparation the mind is apt to construe the performance as either utterly stupid and void of sense, or as an actual reality. The artist copies the results of his imagination or mental perception upon a plane surface. A similar mental preparedness or imagination is essential to those who view the picture. A cow, having no imagination or mental process, preceding the actual presentation of a picture, would view it rightly as a plane surface. A dog, unaccustomed to seeing himself, barks at his reflection in a looking-glass.

Vivid expectation may arise or be brought about (1) by means of *present objective facts*—*e.g.*, the illusions of the conjuror; (2) by *verbal suggestion*—*e.g.*, at séances, and in the hypnotic state; and (3) *imagination*, internal and spontaneous—*e.g.*, the picturing of the various diseases described in text books, is apt in many students to be followed by feelings that the diseases are present as they are considered in turn.

Comparatively permanent disposition.—In the various temperaments there is a tendency to reflect the characteristics of the mental life upon all sense impressions. That is to say, every presentation is toned by the pre-adjustments of the individual's mind. The evolution of conceit in the adolescent is attended by self-exaltation and an illusory interpretation, or deviation from the common or collective estimation of the individual's own powers or attributes. The bilious person perceives his presentations with an accompanying tone of melancholy, and interprets from *his* mental standard. The sanguine and full-bodied muscular individual interprets everything with a halo of hope and well-being. Such a type provides us with the characteristic euphoria of general paralysis. A general paralytic of the nervous type exhibits acute maniacal ravings, whilst one of the bilious type is apt to be melancholic with the onset of the disease. Instances must occur to every mental pathologist where the disease has been attended by the illusory belief by the patient that at last the former dreams and castles in the air are realised. Such instances are common. Poverty suggests dreams of wealth. Inability to help our friends suggests dreams of benevolent gifts and magnificent schemes for the welfare of mankind in general. The onset of a process of degeneration, such as general paralysis, is often characterised by such mental colouring, which is to be explained only by the comparatively permanent disposition of the mind to imagine the unreal. Present subjective realities receive their tone or colouring from a mind more or less saturated with probabilities and imaginary possibilities.

Secondary Sensations. — Let us now briefly consider some of those conditions of perception which have been termed "*secondary*." Some individuals never have a presentation of a certain sense without the occurrence of a presentation of another sense. Thus, some experience a sensation of light with every sensation of sound. Others observe colours with every sound. When the two presentations occur together the condition may be termed one of a *dual presentation* to distinguish it from a *secondary* presentation, in which case the primary suggestion of one presentation is followed by or associated with a secondary and different sensation. Bleuler* has divided these secondary sensations into :—

1. *Sound photisms.* — Sensations of colour acompanying sensations of sound.

2. *Light phonisms.*—Sensations of sound from perception through light.

3. *Taste photisms.*—Sensations of colour from perception through taste.

4. *Odour photisms.*—Sensations of colour from perception through smell.

5. *Pain photisms.*—Sensations of colour from perception of pain, temperature, and touch.

Bleuler and Lehmann found that secondary sensations occurred in seventy-six persons out of 596 ($12\frac{1}{2}$ per cent.). According to the former, secondary sensations are transmissible by heredity. Entire families of colour-hearers are known. Their connection with nervous and mental disease is unproved. Lepsius, the Egyptologist, connected colour with sounds, and used those colours as a guide in his philological inquiries. Galton relates the case of a lady, in which the tendency was hereditary, but not the details ; thus one member of the family might say that a word was blue, and another strongly dissent and say it was green, and some little domestic friction occasionally arose in consequence. Grüber† has tabulated

* "Tuke's Dictionary of Psych. Med.," p. 1125.

† "L'audition colorée et les phénomènes similaires." International Congress of Experimental Psychology. London, 1892.

the various chromatisms and photisms of the senses as follows *:—

Chromatisms	Superior Senses	Sight...	Forms Movements Elements of writing Numbers	Coloured vision.	
		Hearing	Musical sounds Instruments and voice Vowels Diphthongs Consonants Syllables	Chromatisms, Phonetic	Coloured hearing.
			Common names Proper names Days of the week Seasons Months of the year Elements, geographical Homonyms Abstract names Numbers	Chromatisms, Psychic	
Photisms ...	Superior sense	Hearing ...	Noises ...	... *Audition illuminée.*	
Chromatisms (Photisms)	Inferior senses	Taste ...	Bitter Sweet Acid Salt	Coloured taste.	
		Smell	... ...	Coloured smell.	
		Touch...	Touch proper	Coloured touch.	
			Temperature	Very hot Warm Tepid Cool Very cold	Coloured temperature.
		Muscular sensation	Movements ...	Coloured movement.	
			Resistances ...	Coloured resistance.	

* He reserves the term *photism*, introduced by Bleuler and Lehmann, for "*l'audition illuminée*," and includes under the term *chromatism* "les tâches subjectives colorée, qui sont évoquées par l'excitation des divers autres sens."

In addition to these chromatisms and photisms we have various *phonisms*, which may be tabulated as follows:—

Phonisms	Sight	sight hearing.
	Taste	taste hearing.
	Smell	smell hearing.
	Tactual	touch hearing.
	Movement	movement hearing.
	Temperature	temperature hearing.
	Resistance	resistance hearing.

For the inferior senses we have *gustatisms*—viz., sight, sound, and smell-tasting; also *olfactisms*—viz., sight-smelling, sound-smelling, etc. Tactual and temperature sensations may be provoked by the other senses. Thus, we have sight hearing, and taste, giving rise to tactual sensations; also sight or hearing giving rise to temperature sensations. We cannot, however, enter into the details of all these secondary sensations.

Many theories have been offered to explain their occurrence. Bleuler believes the explanation commonly offered—that colour-hearing is due to a simple association of ideas which constantly occur together—to be false. The regularity with which light colours predominate for high notes, etc., does certainly, on this theory, appear to be unexplainable. Bleuler has pointed out that the colours appearing in photisms differ but slightly from the ordinary colours perceived by the eye. The photism colours usually appear as pure colour sensations, separated from all ideas of matter which are associated with every colour surface. They can best be compared with coloured flames, or with evening red in a coloured sky. Photism colours have been observed, although very rarely, which, optically, have never been perceived, and which are, indeed, optically inconceivable. Bleuler himself experienced a photism for the German modified *u* (ü) as a mixture of light-red and yellow, and a little blue without a trace of green. This observer found that the surroundings of photisms—that is, the field on which they appear—are not black, but a neutral ground free from every colour. The transitions from one photism to another frequently correspond to similar changes in common colours; thus, for a colour-hearer, *a* (in "father") may be blue, *o* (in "bone") yellow, and the sound between these two, *oa* (a in "water"), green. Mixtures of colours frequently occur, and follow the ordinary laws which govern the mixing of pigments; for example, the simple photism of a word of two syllables may be orange, because the vowel of the first syllable appears red, and that of the second yellow. The same author gives the following laws concerning secondary sensations *:—

1. Photisms light in colour are produced by sounds of high quality, intense pain, sharply-defined sensations of touch, small forms, pointed forms; dark photisms from opposite conditions.

2. High phonisms are produced by bright light, well-defined outlines, small forms, pointed forms; low phonisms from opposite conditions.

3. Photisms with well-defined forms, small photisms, and pointed photisms, are produced by sounds of high pitch.

4. Red, yellow, and brown are frequent photism colours, violet and green are rare, while blue stands between these extremes.

The observations of Lussana, the brothers Nussbaumer, Bleuler and Lehmann, Lauret and Duchaussoy, Ferdinand Saurez de Mendoza, etc., have demonstrated the influence of heredity in the production of secondary sensations; but, as pointed out by Grüber, all these observations have been made on intellectual and cultivated individuals. It would, therefore, be interesting to ascertain whether these phenomena occur among the illiterate. We do not know how much is hereditary and how much is acquired through cultivation. A second question to ask would be, Do these phenomena fall within the domain of cerebral pathology, or within that of normal physiology? Neiglick and Steinbrügge believe that the phenomena

* Grüber says:—"Mais auparavant il faut ranger les individus qui possédent des sensations doubles (le terme n'est pas assez correct) en deux grandes classes: (1) les individus qui présentent des chromatismes, qui *chromatisent* leur audition, qui associent une sensation secondaire de couleur a l'état hallucinatoire; nous appellerons cet état '*l'état sensationel;*' (2) les individus qui associent constamment et fatalement les mêmes *idées de coleur* aux mêmes sons, etc., qui présentent cette liaison a l'état purement intellectuel *état psychique.* Entre ces deux classes, entre le type le mieux doué et ceux qui n'ont ces phénomènes qu'à un degré très faible et très partiel il y à toutes les transitions possibles."

are abnormal and symptomatic of a degenerative process. Féré and others regard them as the outcome of "*une tonalité particulière de l'organisme.*" On the other hand, Perroud, Chabalier, Baratoux, Mendoza, Urbantschitsch, and others have supported the view that all the phenomena are normal. Others, again, believe that these secondary sensations fall under the category of psychical phenomena (such as hypnotism, dreams, hallucinations, genius, etc.), which, although not exactly normal psychical states, nevertheless, cannot be considered as morbid. They argue that psychical exceptions are not necessarily pathological.

CHAPTER IX.

HALLUCINATIONS.

Distinction between Illusion and Hallucination—The Transition from Illusion to Hallucination—Relation of Imagination to Hallucination—The Neural Process in Hallucinations—The "Bucket Theory"—Anatomical Regions for Hallucinations and Sensations—Varieties of Hallucinations—Classifications.

CLINICAL CONSIDERATIONS.

Statistics of 1,000 Cases—Perversions of Taste—Hypergeusia—Hypogeusia—Ageusia—Parageusia—Perversions of Smell—Hyperosmia—Hyposmia—Anosmia—Parosmia—Perversions of Sight—Entoptical Causes—After Images—Perversions of Hearing—Hyperakusis—Hypakusis—Akusis—Parakusis—Perversions of Tactual Perception—Hyperæsthesia—Anæsthesia—Pselaphesia—Algia—Perversions of the Muscular Sense—Kinæsthesia—Illusions and Hallucinations in Dreams—Hypnagogic Illusions—Dreams in the Insane.

HALLUCINATIONS.

It is often difficult to distinguish between active illusions and hallucinations. This is more particularly the case when the psychic element of expectancy is present to any great extent. Esquirol distinguishes an illusion from an hallucination by the assumption that the former is a false interpretation of a sensation actually present and perceived. In some instances this distinction must be a very fine one. Hack Tuke, however, regards the question as not altogether unimportant, because while men easily, even in a perfectly sane state, convert a real object into something other than itself, they rarely perceive one externally projected, in the entire absence of a corresponding reality, without a more or less grave disturbance of the nervous system. It must be remembered that an insane hallucination, as well as an illusion, may involve a false interpretation.

Both may appear to be purely psychical processes, and, undoubtedly, it is from the psychical side only that we can as yet seek their explanation.

We shall, however, endeavour to understand how far we may attribute their existence to correlated physiological states. Professor Ball believes that even an illusion involves an hallucination, and that there is no fundamental difference between the two.

In hallucinations various sensations may be experienced, although no external objects act upon the peripheral sensory nerves. According to Hack Tuke, such sensations do not constitute insanity, unless they are credited by an individual to be realities under conditions in which reason and experience ought to forbid such belief. It must be remembered, however, that although an hallucination is regarded as the perception of an apparent external object which has no external reality, but which is credited as having an external reality, the genesis may be almost identical with a centrifugal causal operation. Science can seek to demonstrate the physical factors which act upon our peripheral nervous mechanism, but it cannot entirely eliminate all peripheral excitants as possible causal factors of what we term esoneural phenomena. That is to say, even the so-called internal or imaginative processes, although apparently esoneural in origin, may depend upon peripherally initiated factors.

In the transition from illusion to hallucination the processes of imagination come into play without the aid of direct and immediate sensation. It must not be forgotten, however, that the imagination itself is the result of unusual combinations of revived sensations. Were the transition capable of exact demonstration, it would occur at the point where the exoneural factors could be entirely eliminated. How far we are able to determine what perversions are due to the direct implication of sensory tracts, and how far other nervous substances are involved, we shall venture to inquire, but we shall see that, from a physiological point of view, we are unacquainted with the mode whereby there arises that internal facility of increased development or increased production of abnormal images so commonly met with in the insane.

Every perception is somehow dependent upon correlated physically-determined activities. The mental "complexion" gained by the mind's habitual interpretation of presentations, is the psychical complex upon which the incoming impressions assert themselves. To estimate the nature of this mental complexion it is necessary that we should take account of other psychical factors than mere present sensory presentations, physically or physiologically determined. We can, to a certain extent, eliminate external or exoneural stimuli as the initial factors in a sensory presentation; we cannot, however, eliminate from consideration the esoneural factors with which complex mental states are associated. That is to say, in dealing with the factors which determine an immediate presentation to the mind, and those which determine a complex mental state, we must in each instance grant the dependence of the psychic facts upon esoneural phenomena.

Many authors believe that there is little or no difference between imagined and felt objects, and that the cortical processes which underlie them are essentially similar. There seems to be no doubt that genuine sensations may depend upon the activity of the cerebral apparatus alone. Professor James believes that the imagination process differs from the sensation process by its intensity rather than by its locality. He also believes that the imagination process can pass over into the sensation process, but that normally the two processes do not pass over into each other; therefore, either sensation processes occupy a different locality from imagination processes; or, occupying the same locality, they have an intensity which, under normal circumstances, currents from other cortical regions are incapable of arousing, and to produce which involves the operation of the peripheral apparatus.

Before we can admit that sensation processes and imagination processes involve the activities of the same centres, we require much further information with regard to the relative functions of the structural contents of the various sensory areas. We know, in a rough kind of way, that injury, disease, or extirpation of certain sensory areas, serves to prevent ingoing sensory stimuli from reaching consciousness; but, at the same time, we cannot say that this interference with the transmission of ingoing stimuli necessarily, also, interrupts the neural activities with which representations are correlated. The fact that these centres may be partially injured without obvious impairment of the activities of their representative processes is significant, and leads us to the belief that we may yet establish some more definite facts with regard to the structures contained within the sensory areas, and, thereby, possibly throw some light upon the physiological relation between presentations and representations.

The human nervous system resembles in some respects the complicated system of wires in a piano. When a wire in a piano is destroyed in any part of its course no ingoing activities can be transmitted along that wire. Similarly, when a nerve is cut or destroyed the ingoing currents are necessarily interrupted. We cannot push the analogy too far, however, for in the case of the nervous system, although the end-organ of sense is cut off from its centre, that centre can still exhibit activities upon which the revival of past acquirements would appear to depend. That is to say, although the *development* of the brain depends upon the functional integrity of its connections with the periphery, nevertheless, the sum total of the acquirements would appear to be capable of representation centrally in spite of the nerve discontinuity.

Later, we shall see that the *modus operandi* whereby a presentation is recalled or re-presented is a subject about which, as yet, we can only conjecture. We cannot assume that there is activity of the representative elements involved in imagination apart from the instrumentality of its organ, the brain. We can only assume, that the representative element is determined in some way or another by some present and immediate activity, and that the mental state is, or is not, independent of exoneural forces. The belief in the external or objective reality of the representation is in part determined by the character and intensity of the representation itself.

In the ordinary images which are conjured up by memory, association, or imagination, we have a certain feeling of mental activity, and we are aware of the want of objective reality of the things perceived. In hallucinations, however, this feeling of activity is not appreciated. The presentations are more or less spontaneous, sudden, and abrupt, and in their vividness they tend to gain the import of objective realities. Ordinary images can be revived with more or less distinctness at will; hallucinations, which are altogether more vivid, seldom or never. In the former the mind is active and determining; in the latter it is passive and recipient. The instances met with in asylums where the sense presentations are viewed by the individual as having some internal objective reality are very numerous.

Sometimes "mental voices" may possess such a degree of vividness that there arises the belief that they are spiritually superimposed, and that they are not the outcome of ordinary psycho-physical factors. The mind may be regarded as the passive recipient of the presentations, and without any conscious mental preparedness favouring the occurrence of such presentations. In some instances the hallucination may superimpose itself with such vividness that it submerges all voluntary direction of thought, and succeeds in asserting itself to the exclusion of all other incoming sensory or associative processes. Sane individuals are also subject to such experiences. At some time or another we have all felt the influence of a dominant idea which returns and asserts itself in spite of all our efforts to drive it from us. In everyday life our minds are subjected to all sorts and conditions of representations of the senses. Thus, some unpleasant *contretemps*, some act of folly, some painful sight, some hackneyed tune, or sickening odour, will reassert itself, and in its very vividness distract the mind from its immediate surroundings. "Punch brothers, Punch with care; Punch in the presence of a Passengare" is an instance known to every reader of Mark Twain. For the present, however, we have to do rather with the abnormal interpretation of the presentations than with their various modes of asserting themselves in the individual.

Those forms of hallucinations in regard to which the individual recognises a subjective significance, and that they have no objective reality, but which he, at the same time, believes to be superimposed upon his mental being, either by some other influence, or by some system of persecution, are termed pseudo-hallucinations: that is to say, they do not possess the character of objective reality which pertains to an hallucination.

One patient in Bethlem Hospital used to see words in clearly cut characters (sometimes luminous on a grey background, at other times dark upon a luminous background) pass across his brain. The words themselves were quite distinct, and the sentences presented to his mind were full of reproach and sometimes even blasphemy. The interpretation was at fault, inasmuch as he regarded his subjective experiences to be due to some system of persecution brought about by spiritual powers.* This variety of internal reference of the sensory presentation differs from that variety in which, for instance, a voice is thought to proceed from some other part of the organism. Thus, one patient heard a voice which appeared to come from her own throat; another heard a voice, full of condemnation, which seemed to come from the left side of her body. Another, at present in Bethlem, hears the voice of "Ethel" calling to her from her womb. A more interesting instance still was seen at Wakefield. The patient, a music teacher, suffering from epilepsy, had an aura preceding each epileptic attack; each aura consisted in, firstly, distant sounds of music which seemed to proceed from her abdomen, and as the sounds increased in intensity and distinctness they appeared to rise gradually from the abdomen to the thorax, neck, and head, until they reached the vertex, when she lost all consciousness. Dr. Savage mentions a case in which an individual developed the idea that he had a spiritual wife within him who communed constantly with him, and who had prophetic, spiritualistic, and mesmeric powers. In each of these instances some part of the bodily organism was referred to as the source from which the sensory impression was derived. Such inner voices are common among the insane. Their subjective nature is not recognised, and their causation is not attributed to the workings of brain or to the activities of the mind itself.

It is often extremely difficult to distinguish between illusions, pseudo-hallucinations, and true hallucinations. In some

* In stating that the interpretation was at fault, I am keenly aware of the fact that we have no proof against any spiritual interpretation. We know not the *cause* of physical, physiological, or mental manifestations. In mentioning such cases as instances of perversion, I, at the same time, allow that some speculations are not incompatible with sanity.

forms of acute maniacal delirium there may be a combination of all three. The hallucinations which arise in connection with opium, haschisch, and belladonna, are said to resemble those of acute fever delirium in this respect.

The Neural Process in Hallucination.—The point upon which authors differ is in respect to the tracts affected in hallucinations. Some would have it, that the same parts of the nervous apparatus which are concerned with normal sense presentations are also concerned with the abnormal or hallucinatory presentations. They believe that the neural process in an hallucination must consist of an excitement from within of those centres which are active in normal perception, identical in kind and degree with that which real external objects are usually needed to induce. Professor James holds, that the particular process which currents from the sense organs arouse would seem, under normal circumstances, to be arousable in no other way. The supposition of several authors, that the vividness of the hallucination bears a relative proportion to the intensity of the activities arousing that process, need not detain us here, inasmuch as our knowledge does not as yet warrant any definite conclusion.

An ingenious theory has been given by Professor James to account for the neural process in hallucination. He assumes, that when cells in the cortex are excited by impulses passing through associative paths, there is a free discharge of functional activity from these cells to others, and that this diffusion prevents a maximum of intensity being reached at any one point. This "leakage forward" is too rapid for the inner tension in any centre to accumulate to the maximal explosion point, unless the exciting currents are greater than those which the various portions of the cortex supply to each other. He also assumes, that "currents from the periphery are the only currents whose energy can vanquish the supra-ideational resistance of the cells, and cause the peculiarly intense sort of disintegration with which the sensational quality is linked. If, however, the leakage forward were to stop, the tension inside certain cells might reach the explosion point, even though the influence which excited them came only from neighbouring cortical parts." To illustrate his theory, he says:—

"Let an empty pail, with a leak in its bottom, tipped up against a support, so that if it ever became full of water it would upset, represent the resting condition of the centre for a certain sort of feeling. Let water poured into it stand for the currents, which are its natural stimulus; then the hole in its bottom will, of course, represent the 'paths' by which it transmits its excitement to other association cells. Now, let two other vessels have the function of supplying it with water. One of these vessels stands for the neighbouring cortical cells, and can pour in hardly any more water than goes out by the leak. The pail consequently never upsets, in consequence of the supply from this source. A current of water passes through it, and does work elsewhere; but in the pail itself nothing but what stands for *ideational* activity is aroused. The other vessel, however, stands for the peripheral sense-organs, and supplies a stream of water so copious that the pail promptly fills up in spite of the leak, and presently *upsets*; in other words, *sensational* activity is aroused. But it is obvious that if the leak were plugged, the slower stream of supply would also end by upsetting the pail.

"To apply this to the brain and to thought—if we take a series of processes (A, B, C, D, E) associated together in that order—and suppose that the current through them is very fluent, there will be little intensity anywhere until, perhaps, a pause occurs at E. But the moment the current is blocked anywhere—say, between C and D—the process in C must grow more intense, and might even be conceived to explode, so as to produce a sensation in the mind instead of an idea.

"It would seem that some hallucinations are best to be explained in this way. We have, in fact, a regular series of facts, which can all be formulated under the single law that *the substantive strength of a state of consciousness bears an inverse proportion to its suggestiveness.* It is the halting-places of our thought which are occupied with distinct imagery. Most of the words we utter have no time to awaken images at all; they simply awaken the following words. But when the sentence *stops*, an image dwells for awhile before the mental eye. Again, whenever the associative processes are reduced and impeded by the approach of unconsciousness — as in falling asleep, or growing faint, or becoming narcotised, we find a concomitant increase in the intensity of whatever partial consciousness may survive. In some people, what M. Maury has called 'hypnagogic' hallucinations are the regular concomitant of the process of falling asleep. Trains of faces, landscapes, etc., pass before the mental eye—first as fancies, then as pseudo-hallucinations; finally, as full-fledged hallucinations forming dreams. If we regard association-paths as paths of drainage, then the shutting-off of one after another of them as the encroaching cerebral paralysis advances ought to act like the plugging of the hole in the bottom of the pail, and make the activity more intense in those systems of cells that retain any activity at all. The level rises because the currents are not drained away, until at last the full sensational explosion may occur.

"The usual explanation of hypnagogic hallucinations is that they are ideas deprived of their ordinary *reductives*. In somnolescence, sensations being extinct, the mind, it is said, then having no stronger things to compare its ideas with, ascribes to these the fulness of reality. At ordinary times, the objects of our imagination are reduced to the *status* of subjective facts by the ever-present contrast of our sensations with them. Eliminate the sensations, however, this view supposes, and the 'images' are forthwith 'projected' into the outer world and appear as realities. Thus is the illusion of dreams also explained. This, indeed, after a fashion, gives an account of the facts; and yet, it certainly fails to explain the extraordinary vivacity and completeness of so many of our dream-fantasms. The process of 'imaginating' must (in these cases at least) be not merely relatively, but absolutely, and, in itself, more intense than at other times. The fact is, it is not a process of imagining, but a genuine sensational process, and the theory in question is therefore false as far as that point is concerned."

The main objection to this "bucket theory" is, that it will not hold water! As yet we do not know which elements of the sensory areas are active in normal perception. From the physiological standpoint it would appear warrantable to speak of "discharge" and "resistance" in cells; but to extend the possible physiological explanation to uninvestigable psychical causes is unwarrantable. The "accumulation of inner tension to the maximal explosion point" is a purely hypothetical notion in so far as causes or even effects are concerned. With each physiological "explosion" the process would become easier, and, according to many writers, the mental result would diminish correspondingly. Psychologically, however, each revival of the hallucination tends to make it quite equally vivid, or more so, according to the predisposing physiological condition and the intensity of the cause.

Again, in the insane, hallucinations occur very readily, and appear to occupy the whole of the special sensory apparatus. Now, were these hallucinations due to increased tension in the nerve-cells (pathological or otherwise), how could we account for the fact that, if these sensory regions concerned are working abnormally owing to "tension," "resistance," "explosion," etc., they, nevertheless, are able to transmit normal ingoing impressions which in themselves have nothing unusual or peculiarly intense. It is difficult to imagine a pathological process which can involve certain cells and lead to explosive conditions and their sequelæ, and yet at the same time permit them to transmit ordinary currents in a normal manner. If we assume, that the imaginary or hallucinatory process is due to some degree of "inward molecular cohesion" in our brain-cells, and that these brain-cells are concerned with revived images as well as new or immediate ingoing peripheral images, and that a sudden inrush of destructive energy is the determining agent which liberates the accumulation, how are we to account for the fact, that normal stimulation of the said areas by ingoing peripheral currents is not attended by any of the hallucinatory phenomena? That is to say, why is it that the addition of a sudden current from the periphery does not tend to overflow the level of tension in the cells and give rise to an explosion in the form of an illusion? We must assume, either that no such tension occurs, or, if it does occur, that the cells which have to do with revived images are separate from those which have to do with direct sense-impressions. We cannot imagine a cell having a tendency to explode and yet able to carry on its direct and immediate functions unimpaired.

Let us not, however, for a moment imagine that, were we able to demonstrate a distinct structural arrangement for revived images and another for direct perceptions, our difficulties would be overcome. Perception is a presentative-representative process, and involves association of some sort with previously-acquired perceptions or memory-images. This, obviously, also involves the coincidental activities of the structural arrangements for memory-images with every act of perception. Hence, we may fairly assume that, if hallucinations are due to pathological conditions affecting the memory-image regions, then there ought to be some evidence of their abnormal activities with every act of perception, inasmuch as the complete percept would depend upon their aid.

Ward* distinguishes four forms of presentation—viz., (1) The sensory impression; (2) the so-called "revived impression," which is said to fuse with this in perception; (3) the true memory-image of mediate recognition; and (4) general images, the representative element in conception. When we study the amnesic defects associated with disorders of speech we shall

* "Assimilation and Association"—"Mind," Oct., 1894.

see, that any one of these four may be affected without obvious affection of any of the others. Moreover, it is within the bounds of possibility that we may yet, within certain areas, be able to obtain anatomical evidences that demonstrate this differentiation of function.*

There appears to me nothing in the arguments of those authors, who maintain that hallucinations and sensations occupy different brain-elements, that tends to conflict with the general conception of the continuity of imagination and sensation. It seems hardly necessary, therefore, to seek to demonstrate mechanical discontinuity between the ideational and the sensational kinds of process. Indeed, it seems but natural to assume, that just as there may be a psychical seriality of ideational and sensational processes, so there may also be a correlative propagation of physical activity from the ideational to the sensational structures.

Professor James says, "There is a degree of inward molecular cohesion in our brain-cells which it probably takes a sudden inrush of destructive energy to spring apart. Incoming peripheral currents possess this energy from the outset. Currents from neighbouring cortical regions might attain to it if they could *accumulate* within the centre which we are supposed to be considering. But since during waking hours every centre communicates with others by association-paths, no such accumulation can take place. The cortical currents which run in run right out again, awakening the next ideas ; the level of tension in the cells does not rise to the higher explosion-point ; and the latter must be gained by a sudden current from the periphery or not at all."

From this we might imagine, that during waking hours the explosion-point is not reached owing to an overflow along the association-paths. To criticise these views seems hardly necessary, inasmuch as they are so wide of what we actually conceive to occur. We cannot imagine "molecular cohesions," "tensions," "explosions," etc., *only* occurring during sleep, and roused by sudden currents from the periphery. It is

* See Müller, "Archiv. für Psychiatrie," Bd. xxiv. pp. 856—917; also Vialet, "Les centres cérébraux de la vision et l'appareil nerveux visuel intra-cérébral."

during the waking moments that most of the so-called explosions are revealed in consciousness as hallucinations, and not only during sleep. When dreams are suggested by ingoing currents they are of the nature of illusions; when determined by activities through the association-paths, independently of stimulation through the special channels of perception, they are hallucinatory; and the "explosion" is not necessarily determined by currents from the periphery. James gives as a general law that "whenever the normal forward irradiation of intra-cortical excitement through association-paths is checked, any accidental spontaneous activity, or any peripheral stimulation (however inadequate at other times) by which a brain-centre may be visited, sets up a process of full sensational intensity therein." We know that during sleep the character of a dream is frequently determined by a slight peripheral irritation, in which case the dream is more truly an illusion than an hallucination. Also, in hypnotic states, we know that peripheral stimulation is generally necessary to induce illusionary phenomena; but it is a mistake to assert that ordinary hallucinations are started by peripheral currents. In a word, we are unable to say what the actual physiological cause is. Binet believes that ingoing currents from the peripheral nerves determine the actual sensations not only in normal perception, but also in illusionary and hallucinatory states. If by this is meant, however, that all hallucinations and illusions of sense are the results of previous centrifugal stimuli, we are in accord, although we are unable to demonstrate the physiological mode of their revival.

When we are satisfied as to what localities are concerned with the direct presentations of sense to the mind, then we may offer some explanation upon the question as to whether peripheral currents are essential or not. Unfortunately, we cannot eliminate the whole of the ingoing paths from our considerations. We know that after loss of the eyes, after section of the optic tracts, or even removal of parts of the visual centres, the mind still receives representations of sight; but these facts do not enable us to exclude all the length of the ingoing visual path. That is to say, we can cut off all supplies, or possibilities of stimulating the mind through that special sensory tract as high up as the so-called visual centre, but beyond that centre there may be a gap of an unknown physiological nature, which has to be traversed before the actual presentation in consciousness occurs. By this we do not wish to negative the theory that every representation is *in part* determined by some ingoing stimulus; we merely wish to point out that we do not know the extent of the paths which lead from the periphery to the actual region concerned with mental presentations.

All our knowledge arises from (1) internal perception, or introspection of the mind's own feelings; (2) external perception, or perception of things conducted to the mind by way of the senses direct; (3) memory, or the storing up of presentations which can be recalled and represented to the mind afresh; (4) belief in the reality of the new or recalled sense-impression. Departures from the normal psychological or right path of any one of these will bring about abnormal thought, as surely as any departure of the physical organism from its laws of health. The conditions of defective and hazy memory, and the innumerable influences which go to determine belief, must occupy our attention later.

As examples of the actual causes or conditions of hallucinations, Griesinger gives (1) local disease of the organ of sense; (2) a state of deep exhaustion, either of mind or of body; (3) morbid emotional states, such as fear; (4) outward calm and stillness between sleeping and waking; and (5) the action of certain poisons, as haschisch, opium, and belladonna.

Varieties of Hallucination. — The transition from illusions to hallucinations in the insane is very gradual, and some of the grosser illusions shade almost imperceptibly into hallucinations. An hallucination may assume one of two fairly distinct forms. Thus (1) it may be a semblance of an external impression with a minimum amount of interpretation: this variety is rudimentary and common to all of us; or (2) it may be a counterfeit of a completely developed percept.

Fournie* believes that an hallucination is merely a process in which a definite stimulus of this kind originates involuntarily

* "Physiologie Pathologique des Hallucinations," Internat. Congress, London, 1881.

and unconsciously in the cortex, and is sufficiently powerful to induce a belief of its external reality. Hallucinations would thus appear to differ from ordinary acts of memory by their unconscious origin, and by their unusual force. Fournie considers that the sources from which the stimuli are derived form the basis for a classification of hallucinations. These sources are (1) the sensations of organic life; (2) the sensations connected with reproduction; (3) the sensations of the special senses; (4) the sensations produced by the voluntary activity of our organs. The last head including all the higher psychical functions, and speech in particular.

Baillarger has also given the following classification: (1) Hallucinations which are peripherally determined—*i.e.*, by ingoing sensory currents: these have also been termed psycho-sensorial; (2) Hallucinations which are centrally determined — *i.e.*, determined by activities within the sensorium (automatic excitation of the central structures), termed psychical.

Any classification must of necessity be mainly psychological; but at the same time we may be allowed to take account of the possible starting point of the physiological or esoneural correlate. Psychologically considered, hallucinations may be faint or vivid, rudimentary or complete; physiologically considered, they may be associated with processes, which are centrally or peripherally determined.

We have already noted the importance of the whole mental complexion of the moment in determining the actual colouring of an hallucination. Griesinger believes that the imagination plays an important part in determining the character of the hallucination. In the insane the hallucinations are mainly due to a projection of mental images which have gained preternatural vividness and persistence. The rats seen in *delirium tremens* may be classed more truly as illusions than as hallucinations, inasmuch as they are due to peripheral impressions (muscæ volitantes), *plus* emotional disturbances of central origin. Ziehen believes that in hallucinations of the insane the process of sensation, which normally always proceeds from the sensory elements to the memory elements, now takes the reverse course from the latter to the former. He says: "It is only when the sensory cells are morbidly irritable that they react upon a stimulation from the memory-cells, which, under normal conditions, would have no effect upon them, but which has been pathologically intensified. The sensation-cells are sympathetically excited, as it were. It is obvious that but two chief cases are to be distinguished. The ideas that sympathetically excite the sensory cells are either the ideas actually present in consciousness at the time, or the ideas that are psychically latent—*i.e.*, more accurately expressed, the material dispositions that still lie below the threshold of consciousness. In the first case the hallucinations correspond to the momentary content of consciousness; in the second case they emerge from among the latent ideas very suddenly, surprising even the individual himself. It is evident that in general hallucinations of the second class occur only when very considerable changes in the excitability of the sensation-cells have taken place, while the actual conscious ideas produce hallucinations even when the excitability of the sensation-cells has but very slightly increased. For this reason hallucinations of the second class are generally much more vividly perceived than those of the first class, since in the former class the sensation-cells are more affected by the morbid phenomena than in the latter."

If we assume that the sensation-cells are those cells which form the ultimate receptacle for ingoing impressions we must make them responsible for the direct transmission of physiological activities into presentations in consciousness. It would seem, from the remarks of Ziehen, that even though currents may pass through these cells, by way of association-paths to other regions ("memory-cells"), yet, in order that these currents may ultimately manifest themselves in consciousness, they would have to return from the said memory-areas to the sensation-cells. If backward currents proceed to sensory cells, which are morbidly affected and irritable, and which intensify or pervert the functional activities propagated to them, we may reasonably assume that, if the same sensory cells are concerned with the transmission of stimuli which pass forward, and the reception of stimuli which are supposed to pass backward, then these same sensory cells must be affected in a way that allows perfectly normal processes to go on in one direction but not in another. Hitherto, it has not been demonstrated that sensory cells are morbidly irritable in hallucinatory states, and we do not believe that hallucinations necessarily depend upon any hyperæmia of the sensory cells. Let us, however, further illustrate our position by a simple diagram. The sensation-cell is thought to be morbidly affected, so that currents passing from M are morbidly intensified—that is to say, the currents

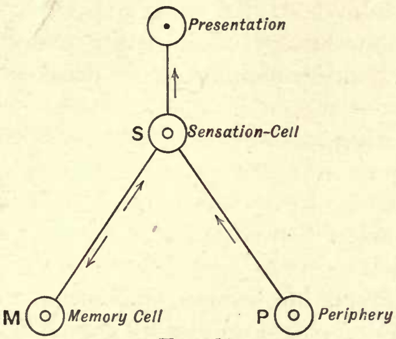

FIG. 15.

transmitted backwards from the "memory-cells," through the association-path M S, become intensified owing to the pathological state of S; in reality, however, we know that, even with the most gross hallucinations of the insane, normal currents can be transmitted along the line P S and thence along S M, or they may arrive intact in their normal operativeness at the region apposite to the mental occurrence.

Clinical Considerations.—Baillarger pointed out that visual hallucinations are more frequent than auditory in healthy life, but that in disease the auditory are the more frequent. The comparative frequency of the occurrence of sensory perversions is of interest, but we cannot devote much space to it here. Esquirol found that 80 out of 100 insane patients had hallucinations. Brierre de Boismont found 38 out of 62 patients. The following table is constructed from the records of the last 1,000 cases admitted to Bethlem. In many of the cases it was difficult to determine whether the perversion was mainly illusory or hallucinatory, so that the numbers may be regarded merely as indicating sensory perversions.

From an analysis of the said 1,000 cases admitted to Bethlem Hospital, it was found that sensory perversions were present in the following order:—

Hearing - - - - -	506
Sight - - - - - -	359
Common Sensation - -	221
Smell - - - - - -	194
Taste - - - - - -	161

From the previous history of the patients, it was ascertained that during the earlier periods of the attacks the perversions were as follows:—

Hearing - - - - -	567
Sight - - - - - -	510
Taste - - - - - -	254
Common Sensation - -	243
Smell - - - - - -	191

It was also found that before admission

159 had had no sensory perversion.
303 ,, ,, one sense affected.
299 ,, ,, two senses ,,
150 ,, ,, three ,, ,,
62 ,, ,, four ,, ,,
27 ,, ,, five ,, ,,

On admission and during their stay in the hospital

292 had no sensory perversion.
297 ,, one sense affected.
219 ,, two senses ,,
100 ,, three ,, ,,
57 ,, four ,, ,,
35 ,, five ,, ,,

Of those who had two senses affected, the commonest combinations were those of sight and hearing, and smell and taste. When three senses were affected, the combinations were commonly sight, hearing, and common sensation, or smell, taste, and common sensation.

In order that we may more fully appreciate the influence of the various senses and their perversions of function in the production of morbid perceptual processes, we must now devote our attention more particularly to the consideration of the special senses themselves in their morbid aspects; and, first of all, we discuss the various perversions of taste.

Perversions of Taste.—We have already considered the different gustatory qualities and their relation to after-tastes and secondary olfactory sensations. The subjective gustatory impressions amongst the insane are very frequently due to pathological causes, arising either peripherally or centrally. Thus, diseases of the tongue, as well as dryness of the mouth, caused by interference with the salivary secretion, may interfere with the sense of taste. The administration of morphia hypodermically is sometimes attended by bitter or acid tastes. Briefly, the various perversions may be described as occurring in the form of (1) *hypergeusia*—exaltation of the sense of taste, *i.e.*, there is a morbid exaggeration of all gustatory sensations, as seen in some forms of neurasthenia, extreme nervousness, and sometimes even in conditions of mania or melancholia. (2) *Hypogeusia*—diminution of the sense of taste. After ice has been sucked, there is often a diminution; as also in acute maniacal or melancholic states, in cases of stupor with general blunting of the sensibility, and in general paralysis of the insane, where there is often a marked loss of perception of flavours and tastes. (3) *Ageusia*—absence of sense of taste, as seen in various forms of paralysis; either manifested as a progressive loss, as in general paralysis, or as a sudden loss in some forms of apoplexy, or other organic conditions. (4) *Parageusia*—perversion of the sense of taste, as seen in nearly every form of insanity: thus, one patient tastes sulphur, another complains of vile filth in her food. Dr. Savage says illusions associated with ideas of poison are more common than true hallucinations. "In many cases, young women with ovarian disturbances, and, perhaps, sickness, refuse food, complaining of bad smells and tastes of poison. I have seen the same refusal of food due to the same hallucinations in a woman who had had children, and was, therefore, used to the vomiting of pregnancy; yet, when insane, she explained her sickness as due to metallic poisoning. In phthisis, again, patients frequently refuse their food, believing they are being poisoned. Insane patients may complain of poisoning, or of acid tastes allied to that produced by electricity, but very commonly the complaint is either that drugs are put into the food, with the intention of producing insanity or insensibility; or that filth of some kind, most commonly fæcal, is administered with drink or meat. Others fancy human flesh or blood is given them". . . . "Hallucinations of taste may occur with ordinary mania, but are more common in melancholia, and in conditions of weak-mindedness."* It is not uncommon to be able to trace the origin of such sense-perversions to the element of expectancy. One patient now in Bethlem first experienced a feeling of *malaise* and weakness. Subsequently, he misinterpreted his sensations, and attributed their occurrence to external agencies. Later, he thought of poison, and prepared his mind to analyse all his taste-sensations, with the result, that soon all ingoing gustatory impressions became coloured with his mental complexion, and definite illusions of taste prevailed. This would appear to be the true explanation of the majority of such perversions. It is comparatively rare to find a pure parageusic condition untempered by mental preparedness.

Perversions of Smell.—The statement of Bidder, that odorous bodies taken into the mouth and then exhaled through the posterior nares are not smelt, is certainly not true. Our perception of flavour depends in great part upon the sense of smell. The various perversions of smell may be divided into: (1) *Hyperosmia*—a morbidly acute sense of smell; a term also applied erroneously to olfactory illusions or hallucinations. It is not uncommon in certain forms of hysteria, and allied neuroses, especially when associated with disorders of the reproductive organs. (2) *Hyposmia*—a blunting of the sense of smell, as seen in cases of stupor, acute mania, dementia, idiocy, and general paralysis. (3) *Anosmia*—absence of smell, as in the various organic paralytic affections of the insane. In hypnotic states by suggestion, the sense of smell is soon blunted, or even paralysed. Lichtenfels and Fröhlich found that morphia, when mixed with a little sugar and taken as snuff, paralyses the olfactory apparatus, while strychnine makes it more sensitive. (4) *Parosmia*—perversion of smell. In the insane this variety is much more frequent, and it arises very similarly to that of taste. In any acute form of mental disorder there

* Savage, "Insanity," p. 243.

is a liability to misinterpret actual olfactory stimuli. Dr. Savage points out, that "occasionally in the excitement of mania and of general paralysis, there are pleasant hallucinations of smell; but that in many cases of mental depression, especially those associated with ovarian and uterine trouble, the smells are of an unpleasant kind: one woman complaining of dead bodies near her, while another thinks a smell of dung pervades the room, or emanates from her own body. A few complain of a pungent odour, like that of ammonia, and certain 'miserable sinners' complain of a foretaste of hell in the shape of smells of brimstone." In melancholic cases, it is not uncommon to find, that the mind misinterprets an actual olfactory stimulation proceeding from a disordered stomach, and that the illusion takes the form of offensive and foul odours, to which are given false objective significance. It would be easy to multiply such instances.

Perversions of Sight.—The various entoptical phenomena, which depend upon the perception of objects present within the eyeball itself, briefly enumerated are: (1) *Shadows* formed upon the retina by opaque bodies. These are (*a*) the *spectrum muco-lacrimale;* (*b*) wrinkled shadows, due to folds in the cornea; (*c*) lens shadows; (*d*) muscæ volitantes. (2) *Purkinje's figure*, due to a shadow of the blood-vessels within the retina cast upon the most external layer of the retina. (3) *Movements of the blood-corpuscles* in the retinal capillaries. (4) *The entoptical pulse*, due to mechanical irritation of the rods lying outside the pulsating arteries. (5) *Pressure phosphenes.* (6) The *ring*, observed when the eyes are moved rapidly backwards and inwards, and which corresponds to the entrance of the optic-nerve. (7) The *accommodation spot.* (8) *Mechanical optical stimulation*, division of optic-nerve causes flash of light, etc. (9) *The accommodation phosphenes.* (10) *Electric phenomena.* (11) The *yellow spot:* "Löwe's ring" and "Haidinger's Brushes." (12) *Spectra*, arising from internal causes, such as increased blood-pressure through retina, etc.

McDowall* believes that more colour-blindness exists among the insane than is to be found among ordinary individuals. Of 324 women he found that nine were evidently more or less colour-blind; whilst, of 207 males, thirteen were more or less

* "West Riding Asylum Reports," vol. iii. p. 129.

unable to distinguish colours. Of these latter, five were dements, five general paralytics, and three were epileptics. An analysis of his results, however, does not lead us to the same conclusion. Undoubtedly among idiots and imbeciles, the discriminative power of detecting colours is often deficient; but we attribute this more particularly to deficiency in the mental development. Batty Tuke has observed local colour-blindness in the second stage of general paralysis.

The phenomena of after-images, and the numerous false estimates of size and direction have already been discussed; it only remains, therefore, for us to speak of the perversions met with among the insane. Faces are very commonly seen by the insane. Frequently the face seen is a familiar one superimposed upon some actual existing object. One patient, now in Bethlem, sees and recognises those around him, but detects sneers and horrible expressions, which he believes are superimposed upon the actual expressions by some spiritual influence which is specially designed to affect his subjective appreciation of the external objects. Hallucinations of sight are common in delirious states. In other forms of insanity the mental state often determines the character of the hallucination. In epileptic states the *aura* is commonly a visual one. A certain amount of expectant attention determines the character or ideational intensity of hallucinations in a number of individuals.

Collective hallucinations are supposed to have a common origin for all percipients. Their origin is thought to be (1) *telepathic—i.e.*, some other mind affects them similarly and simultaneously; or it may be by (2) *physical suggestion*, by which is meant, some real external cause starts, by suggestion, similar perversions in all. The evidence that an hallucination is ever thus produced is questionable, and it is sometimes difficult to account for the occasional agreement of the two senses otherwise than by the aid of self-suggestion operating during an hallucination. (3) A third explanation of collective hallucinations is, that A sees an hallucination first and then conveys it by word or gesture to B. In this explanation there are many difficulties, but a supposition is feasible, that the likeness of the hallucination may be the result of pseudo-memory and the after-comparison of details. (4) A fourth hypothesis—viz., that the hallucination of one percipient is caused by mental suggestion or thought-transference from others—is inexplicable.*

Some persons fail to perceive an hallucination when the eyes are closed; others perceive the imaginary object equally well whether the eyes are open or shut. Dr. Hack Tuke holds, that when lateral pressure is made upon the eyeball of one eye a subjective image is never doubled, and that doubling never occurs without an external object being seen. "Further," he says, "the after-image of a luminous object obscures, or entirely conceals, real objects, moves with the motion of the eye, and is 'projected' when the observer looks on a dark ground. All this may be true of visual hallucinations, and, when the principle is applicable, we must regard them as involving the retina. If, however, these conditions are not observed, we infer that the visual hallucinations do not involve the retina, but are confined to the cortical sensory centres, or possibly they extend to the sensorium. Certain it is that hallucinations of sight may occur when the optic-nerves are atrophied, and therefore the retina is not the seat of vision."

Ritti and Christian believe that hallucinations have their seat in the optic thalami, "from whence peripheral impressions irradiate to the various regions of the cerebral cortex. The cells of the latter respond to the false indications conveyed to them as if they were real."† Sometimes visual hallucinations occur in one of the lateral halves of the visual field, and they are found usually, but not invariably, associated with a corresponding hemianopia. These have been observed in the sane, as well as in those subject to epilepsy, migraine, anæmia, and delusional insanity. When coincident with hemianopia, such hallucinations probably originate in a cortical irritation or malnutrition limited to the occipital lobes.

Spitzka believes that visual hallucinations are next in frequency to those of hearing. They vary from blurs, clouds, or haloes, to flashes of light, bright colour-perceptions, faces and figures of persons, animals, etc. Shaw sums up their occurrence as follows:—Especially frequent in acute delirium, and *delirium*

* "Census of Hallucinations," Psychical Research Society.

† "Tuke's Dictionary," p. 568.

tremens; in the latter disease they are painful, mobile, nocturnal; in the former terrifying; occur also in alcoholic pseudo-general paralysis; monomania, especially the religious form; chronic alcoholic insanity, painful, mobile, nocturnal; early stages of terminal dementia; acute and chronic mania; puerperal insanity; lactational insanity; general paralysis; painful and terrifying in chronic insanity, acute and sub-acute rheumatic insanity; and in melancholic form of delirious saturnine insanity; worse at night in insanity of cyanosis from bronchitis, etc.; in pneumonic consecutive insanity; saturnine pseudo-general paralysis; sometimes in consecutive post-febrile consecutive insanity; insanity of myxœdema; insanity of abdominal disorders; frightful in some cases of delirium of young children; in epileptic, and hysterical insanity.

In general paralysis hallucinations and illusions of sight are not infrequent during the early stages; but of a total (100) of general paralytics, Mickle* found that visual hallucinations were present in forty-one. He concludes that the relative proportion of the visual to the auditory hallucinations is much higher in general paralysis than in the other forms of insanity, taken collectively, as found in our asylums. Excluding idiocy and imbecility on the one hand, and, on the other, general paralysis, he says, it is probable that auditory are more frequent than visual hallucinations in a given asylum population in this country. This he attributes to be partly due to the chronicity of most of the cases, for in the acute forms of insanity visual hallucinations are relatively far more frequent than in the chronic.

Perversions of Hearing.—It would be impossible to discuss here all the pathological states which give rise to entotic sensations. The "damping apparatus" of the tympanic membrane may be working ineffectively so that "sympathetic" vibrations or after-vibrations occur more readily; or thickenings or inequalities of the membrane may interfere with the acuteness of hearing, owing to the diminished capacity for vibrations thereby produced. A similar result is produced when there are holes in, or loss of, its substance. Increased tension also renders it less sensitive to sound-waves.

When the auditory ossicles are rendered immobile by adhesions

* "General Paralysis," p. 67.

or anchylosis there is diminution of vibrations, and hearing is interfered with ; similar results occur when the stapes is firmly anchylosed into the fenestra ovalis. The Eustachian tube may be occluded owing to chronic catarrh and narrowing from cicatrices, hypertrophy of the mucous membrane, or the presence of tumours ; similarly, effusions into, or suppuration within the tympanum interfere with the conduction of sounds. Köppe* found that out of thirty-one insane patients who had disease of the ear, seven had a chronic hyperæmia of the vessels of the handle of the malleus, and, besides the subjective aural sensations, aural illusions, and hallucinations, Galton† found that when changes in the vascularity (*e.g.*, hyperæmia of parts both within and without the head) are simultaneously brought about by the action of a certain drug, similar changes may be recognised, but not invariably, in the vascularity of the tympanic membrane ; also, that with certain cerebral disorders—*e.g.*, epilepsy, such as would tend towards, or be produced by, a hyperæmic condition of parts at the base of the cranium—there is sometimes, but by no means invariably, correlated a hyperæmic condition of the vessels of the tympanic membrane. These results, however, have not been confirmed by others, and we still lack more complete information upon the conditions in general paralysis and other forms of mental disease.

Of the influence of *intra-labyrinthine pressure* we know very little. We believe that with diminution of the pressure of the air in the tympanum there is a corresponding diminution of the intra-labyrinthine pressure, while conversely, every increase of pressure is accompanied by increase of the lymph-pressure (Bezold). According to Nasse, the *endolymph* flows through the arachnoid sheath of acoustic nerve into the subarachnoidal space. The *perilymph* of the inner ear flows away chiefly through the aqueductus cochleæ, in the circumference of the foramen jugulare, into the peripheral lymphatic system, which also takes up the cerebro-spinal fluid of the subarachnoidal space, while a small part drains away to the sub-dural space, through the internal auditory meatus.‡ That modifications of

* "Von Tröltsch," American Translation, 2nd edit. New York, 1869.

† "West Riding Asylum Reports," vol. iii. p. 259.

‡ Landois and Stirling, p. 811.

the pressure of cerebro-spinal fluid may interfere with the intra-labyrinthine pressure may be readily conceived, and possibly it may be to some source such as this that many of the acoustic perversions in the insane may be traced.

The mechanical relation between the vascular wave and the removal of the lymph-current during sleeping or waking moments is of great importance. In excited brain-states the effects of the vascular wave may be interrupted or irregular. In sleep, regular peristaltic vascular movements are absolutely essential to complete chemical restitution, and to the abstraction of waste products. Thus, we can conceive, that variations in the pressure and quality of the lymph-fluids may act as direct stimulants upon the acoustic apparatus and set up ingoing currents which are misinterpreted by the mind.

The *after-vibrations* caused by intense and continued musical tones may be attended by subjective auditory sensations. Mechanical stimulation of the auditory fibres by abnormal movements of the blood in the ear may give rise to *tinnitus aurium*. Ménière's disease, and vertigo generally, cannot be entered into here. The condition known as *agoraphobia*, however, ought to be briefly mentioned. In this disorder the patient can walk quite well in a narrow lane or street, but when he attempts to cross a wide square he experiences a feeling somewhat like giddiness.

Variations in the excitability of the auditory apparatus, together with the resulting subjective sensations, may be classed as:—(1) *Hyperakusis*, in which there is increased sensibility. This may be due to anæmic or hyperæmic states. Kirchner has pointed out that the vaso-motor effects of certain drugs (quinine or salicine) upon the vessels of the labyrinth produce tinnitus. When the stimulation is excessive, it may give rise to painful impressions, which condition is known as acoustic hyperalgia (Eulenberg). In delirious conditions the excitability is often so well marked that ordinary stimuli are morbidly intensified. In some hysterical and highly-nervous persons all ingoing sensations are greatly exaggerated. The so-called "paradoxical reaction" is produced when a galvanic current is applied to one ear, and there is, in addition to the reaction in this ear, the opposite result in the non-stimulated ear.

(2) *Hypakusis*—diminution of sense of hearing, seen in various forms of insanity—*e.g.*, anergic stupor, paralytic insanity, general paralysis, etc. (3) *Akusis*—deafness; congenital, as in some forms of idiocy; or acquired, as in forms of idiocy or imbecility where the deafness and mental defect follow some acute fever or injury. (4) *Parakusis*—perversion of sense of hearing, as in the ordinary illusions and hallucinations. In the insane the forms they take are endless. Any of the entotical conditions already mentioned may give rise to sensations which are misinterpreted and projected externally.

(1) The insane person may receive stimuli from without in a normal manner, but the mental complexion submerges the actual external object, and an illusion results; (2) the physical auditory apparatus may distort an ordinary stimulus and present an illusory result to the mind, by which it is perceived as such or not; (3) entotical conditions may determine ingoing currents, which are perceived as illusory, or they may be misinterpreted; (4) stimulation of the auditory centre itself may give rise to hallucinations; (5) hallucination may occur in deaf people; (6) the mind itself may become so saturated with an auditory idea, that it preperceives the looked-for stimulus; (7) hallucinations of hearing may be unilateral.

Voices are by far the most common forms of auditory hallucinations, and frequently they cause the patient to become homicidal or suicidal. Some patients think they have "loud thoughts," and that everyone can ascertain what they are thinking about. One case of interest is recorded by Dr. Savage. The patient thought the voices came through a telephone. One night he was told by a voice that it was due to the pulsation of the brain; but he thought that it might also be due to the imperceptible action of his own organs of speech, for he found that, when he thought intensely, the tongue moved slightly. According to Haslam and others, insane patients become deaf more frequently than blind, and the deaf are more liable to insanity than the blind. In intra-cranial disease (*e.g.* tumour) it is much more common to have optic neuritis and affections of sight than deafness or perversions of hearing. Bastian believes the explanation is to be found in the fact, that the impairment of hearing due to intra-cranial disease is less apt to be bilateral

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than impairment of sight from the same causes. To test whether the deafness is entotical in origin or due to primary nervous disease, a vibrating tuning-fork is applied to the scalp either in the middle line or towards one or other ear. In the former affection the vibrations are heard more distinctly on the affected than on the non-affected side, while in the latter they are heard less distinctly. This test, however, does not answer invariably, and when applied to discover entotical causes of perversion in the insane there is no result, inasmuch as the mental element, or preparedness, is, by the nature of the experiment, eliminated also.

The various pathological affections of the auditory nerves may occur (1) at their terminal expansions within the temporal bone. Exostoses, tumours, syphilis, or other diseases may cause unilateral affections by involving the cochlea or the nerve itself; similarly the auditory nerve within the internal auditory canal may be damaged by injury or disease. (2) The auditory nerves between the surface of the medulla and the internal meatus may become implicated by basal meningitis of a specific or non-specific character; their sheaths may be thickened, or may become the seat of new growths, or they may be pressed upon by new growths originating in other parts, as in the under and inner part of the lateral lobe of the cerebellum, or of its flocculus. Possibly, affections of the basilar artery, from which minute vessels are given off to supply the auditory nerves and the internal ear, may cause perversions of the functions of the auditory apparatus. (3) Anæmia, hyperæmia, hæmorrhages, or softening, tumours, or other pathological conditions affecting either the nucleus of origin, or of the root-fibres of the auditory nerve within the medulla, would be apt to cause sensory perversions. According to Bastian, the diagnosis of these cases would have to include other co-existing signs of disease of the medulla. Small focal lesions or tumours would be apt, also, to affect the nucleus and root-fibres of the facial. In disseminated sclerosis the nucleus or root-fibres of the auditory nerve may be involved on one, or even on both sides, without any implication of the facial nerves.*

Of the various affections of the cortex-cerebri which give rise

* Bastian, op. cit., p. 458.

to disordered action we shall speak later. Blandford * believes, that hallucinations of hearing are not so common in very acute forms of insanity, such as acute delirium and delirium tremens, and that in the fevers and delirium of ordinary disease they are found far less frequently than those of sight. He says: "Where we notice them in the insane, they are for the most part chronic, and the acute stage, whatever it may have been, has passed away. And yet, judging by the few cases I have seen, in which I have been able to watch the progress of the disorder almost from the commencement, I am inclined to think that there is a transient-acute or sub-acute stage at the commencement of every such insanity." He also points out that, whereas hallucinations of sight are commonly associated with a condition of deep exhaustion, whether of mind or body, hallucinations of hearing certainly do not merit the name of asthenic. The "central" pathology of auditory hallucinations is quite unknown to us. We refer to various affections of the so-called auditory centres, and think that by so doing we satisfy our minds as to what actually happens. When, however, we reflect that a pathological state which would account for morbid influences determined centrally fails to alter, modify, or pervert in any way the normal functions determined from the periphery by external agents, we feel confused, and must confess that such pathology is for the present incomprehensible. It is scarcely necessary to return to this subject, so we conclude with a brief summary of the kinds of insanity in which hallucinations of hearing occur.

According to Blandford, patients of fifty or sixty years of age are not generally afflicted with voices, unless they have retained them from an earlier period. In cases of melancholia at the climacteric period they are comparatively rare. Hallucinations of hearing are more common under the age of thirty. At the period of pubescence they are not common; when the patients are past childhood and have reached the state of manhood and womanhood they seem especially prone to them. In the hereditary insanity of adolescence, and in the insanity of masturbation they are especially frequent. On the other hand, they are rare in hypochondriacal, senile, phthisical,

* "Journ. Ment. Science," vol. xix. p. 507.

metastatic, traumatic, rheumatic, podagrous, and syphilitic insanities. "In short," says Blandford, "insanity, complicated with other diseases, seems to be free from hallucinations of hearing, which are chiefly to be found in the idiopathic and hereditary disorder, which comes on from some mental cause, or even without any assignable cause whatever." Voices are more common in chronic female patients than in male (Blandford). Savage confirms the observations of Blandford in regard to the age of the patients, and believes that hallucinations of hearing are most common in youth, and from that to middle life, and that they are oftener met with in women than in men. Auditory hallucinations are very common in delusional insanity, and more especially in the persecutory and ambitious forms. Griesinger says they are specially frequent in connection with diseases of the abdomen and genital organs; mania, acute, chronic, and delusional; melancholia, acute and delusional; delirium tremens; chronic alcoholic insanity; puerperal insanity; climacteric insanity; general paralysis; early stage of terminal dementia; post-febrile consecutive insanity; pneumonic consecutive insanity; choreic insanity; of a disagreeable character in melancholic uterine insanity; insanity from deprivation of senses; insanity of myxœdema; and lactational insanity.

The question has been asked, How far are hallucinations compatible with sanity? If the mind is able to correct and appreciate the phenomena as hallucinatory, then they are compatible with sanity; inability to recognise that fact, however, constitutes insanity. From this point of view, therefore, hallucinations of hearing may be grouped into two great divisions: in the one the reason is not lost, and self-control remains; whilst in the other, in addition to the actual hallucination, there is belief or delusion as to the objective reality of the thing heard, and the actions of the individual are affected in consequence. The belief in their objective reality does not necessarily, however, constitute loss of reason; but the presence of "false" belief or perception which the reason may deal with.

Before leaving this subject, we must briefly mention that some patients are not only subject to psycho-auditory hallucinations, but they may also be troubled by hallucinations which are psycho-motor in origin. Such patients are conscious of internal voices which are really due to the formation of psycho-motor word images. Seglas* gives several interesting examples of these psycho-motor hallucinations. He believes that they follow closely upon the psycho-sensory forms, and that they indicate a more advanced disorder of brain-function. It is not uncommon to meet with patients who complain that words are put into their mouths, and that they are forced to articulate them audibly. Sometimes they imagine that their innermost thoughts are made public in this way.

Perversions of Tactual Perception.—Among the insane, illusions and hallucinations of the tactual sense are very common. Following the plan adopted with the other senses, we may classify the various conditions met with as follows:—

1. *Hyperœsthesia,* in which there is an excessive or exalted sensibility depending upon a too great sensitiveness to impressions of the sensory-nerves, or a too acute perception by the nerve-centres of these impressions. By some it is limited to the more acute perception of painful sensations. It may be purely functional as well as organic in its origin (Tuke). Hyperæsthesia occurs after unilateral section of the cord, or even only of the posterior or lateral columns. That the excitability of the cord is intimately dependent on the character of the circulation was pointed out more than two hundred years ago. In insanity it is met with in some forms of hysteria, and, as a temporary condition, in the early stages of general paralysis. According to Shaw it is also met with in some cases of senile dementia and traumatic insanity; and it may be prodromal of apyretic delirium tremens, and of alcoholic pseudo-general paralysis. We know little about the normal physiology of tactual sensation so far as the mind is concerned, so that we are unable to hazard any conjectures as to the ultimate and actual pathological conditions which would give rise to its perversions. We can gain some idea, from general text-books on medicine, how ingoing currents may be stopped, but the condition which ultimately determines exaltation of function or mental hypersensitiveness is not known.

* "Les Troubles du Langage chez les Aliénés," 1892.

2. *Anæsthesia*—diminution of sensibility. In the insane, cutaneous anæsthesia is found in hysterical conditions; in organic brain diseases; in alcoholic pseudo-general paralysis; and in traumatic insanity; in some forms of stupor; in patches in some forms of chronic mania or delusional insanities due to alcohol, etc. There may also be partial or complete loss of sensation in one half of the body in hysterical patients. When the *hemianæsthesia* is complete, ordinary tactile sensation, sensations of cold, heat, and pain are all in abeyance; the skin may even be destroyed without causing pain. The loss of sensation extends, as a rule, up to the median line of the body, and includes the mucous membranes and deeper structures, such as bone and muscle. The means of distinguishing it from paralytic hemianæsthesia are as follows:—Ovarian tenderness persists on the affected side; in fact, is frequently intensified; reflex actions remain unchanged, and the pupils dilate when the skin is irritated. Moreover, the fingers of the affected side can still be used in performing various delicate operations, even when the eyes are closed or directed away from them. When partial, sensation may be lost to either pain or touch, rarely to temperature alone. The affection is more common on the left side, and may be permanently confined to one side, or shift from one side to the other. The transfer of the anæsthesia may also be "induced" by agents which stimulate the skin and cause capillary dilatation, by the application of metals or magnets. These agents have no special power over the anæsthesia, the action being apparently due to autosuggestion, since the transference is not affected during sleep, or when the patient is under an anæsthetic. The hemianæsthesia may come on after a hysterical seizure or quite spontaneously, and drawing attention to the affected side appears to increase the intensity of the anæsthesia (Gowers).* De Crozant† tried to prove that anæsthesia is almost invariably one of the prodromal symptoms of general paralysis; this, however, has been discredited by Guislain and others. Mickle believes that it is a not unusual symptom during the first stages of general paralysis.

We have already seen that diminution of sensibility may be

* Quoted from "Tuke's Dictionary," p. 581.

† "Société de Méd. de Paris," Fév. 26, 1846.

due to (1) the number of tactile nerves in the part touched; (2) the degree of mobility of the part; (3) the modes of application of the stimulus; and (4) the condition of the mind in regard to attention and preparedness when the stimulus is applied. In addition to these influences (5) anæmia, produced by elevating the limbs, or venous hyperæmia, by compressing the veins, blunts the sense; (6) cold acts similarly; (7) previous exertion of the muscles under the part of the skin tested sometimes diminishes the sensibility; (8) some poisons—*e.g.*, atropin, daturin, morphin, strychnin, alcohol, bromide of potassium, cannabin, and chloral hydrate, etc.

Before discussing the various forms of paræsthesia we must mention that the terms "*hyperpselaphesia*," "*hypopselaphesia*," and "*apselaphesia*," have been employed to signify increase, diminution, and loss of tactile sensibility, respectively. Landois found that in himself, pricking the skin of the sternum over the angle of Ludovicus was always accompanied by a sensation in the knee. Obersteiner records the case of a patient, with degeneration of the posterior columns of the cord, who was unable to say whether his right or his left side was touched ("Allochiria").* Variations in the excitability of the nerves to pain have been classified as *hyperalgia*, *hypalgia*, *analgia*, and *paralgia*, to denote exaltation, diminution, absence, and perversion, respectively. The term *neuralgia* is employed to indicate severe paroxysmal shooting pains, etc. Undoubtedly the various forms of paralgia are most frequently met with among the insane. The sensations of flushing, itching, creeping, formication, cold, burning, etc., referred to the skin in a sane individual, are sometimes interpreted by the insane as due to external agencies, such as electricity and various methods of persecution. Such conditions are common in climacteric insanity. Savage says: "Where we have ovarian troubles we may expect to have hallucinations of smell and touch." Régis denominates those hallucinations *genital* which cause different kinds of voluptuous or painful sensations in the genital organs. It is not uncommon to meet with various insane interpretations of painful sensations. In melan-

* Landois and Stirling, p. 838.

choliacs a painful impression from the periphery may give rise to delusions that they are being magnetised, or that the skin is full of vermin. One melancholic patient in Bethlem believed his legs were full of water, and no arguments would suffice to prove that such was not the case. Sometimes in the insanity of puberty and adolescence there are morbid sensations of the skin, which are attended by a delusional interpretation. In chronic alcoholism we sometimes meet with patches of cutaneous paralgia. One individual believed that his leg was being continually bitten by fishes. It is, however, in the various forms of persecutive delusional insanity that such phenomena are most prevalent. Every person who has to do with the insane can multiply instances of cutaneous sensations of a painful nature being misinterpreted as evidences of persecution. A good instance of this form of persecution is to be found in the following case. The patient himself writes :—

"How much longer do you consider my head will stand the knocking about and drilling through of your needle-fork, and switchback blackleg confederation administered from the fourth gallery? Last night I was too tired and weary to prevent them wrenching two successful helios through my eyeballs. Those who are guilty of this continual treatment and attacks, would, if outside, in some places be publicly executed or lynched, and I should be only too satisfied to take a leading part in their chastisement. My body and person are also seriously and indecently interfered with. I would only be too pleased to retaliate if I had an opportunity. Your repeatedly ignoring this state of things only aggravates the evil and stimulates those feeding the winders to greater encroachments. After bath this day I had hoped that the overhead forking and needling would have ceased. However, operations were commenced with a thong through my temple and the needle in my head, which all went off with a smash at 5.45 p.m. Last night and all to-day the nuisance and cruelty has continued as usual. Another patient had a sad experience of the general blackguardism, to-day, and it appears that there are several victims being worked up to keep this needle-form business going, hence their irrational conversation. So far as I can understand, each officer has a mock duplicate to check the form before its final delivery."

"P.S.—Since writing the enclosed my head has been knocked about, and balls of a sulphurous taste injected into my throat with a view to making a helio. To save further misunderstanding I will prevent all this business, even at the risk of losing my sight, or the breaking up of my head altogether."

The disturbances of sensation with reference to the pain of visceral disease is a subject which has found an able exponent in Dr. H. Head. He believes that there is an intimate connection between the central connections for the sensory nerves of the viscera and the nerves which supply the sensation of pain, heat, and cold, and also those which exert a trophic influence on the skin. From his well-known researches, he concludes that the central connections of the pain fibres from the skin and viscera are closely connected with one another. The central connections of the nerves for heat and cold, and for trophic disturbances in the skin, must also be in somewhat close association, though probably not actually connected. On the other hand, the nerves for touch from the skin are widely separated centrally from those of pain.* He has pointed out, that visceral disturbances produce pain at certain points on the surface of the body, and that this pain is frequently accompanied by more or less definite areas of superficial tenderness. In the case of the head, each organ is regarded as standing in relation with one or more areas on the surface; to these areas pain is referred, and over them the skin may become tender, when the normal condition of that organ is disturbed. He concludes that the tender areas on the body do not represent the supply of posterior nerve-roots, but that they correspond to the distribution of segments of the spinal cord; whilst those on the head represent neither the posterior roots of the cervical nerves nor the three branches of the trigeminal. "One might then suppose," he says, "that the analogous areas on the head and neck also represent cephalic segments. But so much shifting has taken place in the head, that we cannot say whether each area on the head is to be considered the equivalent of a whole zone from dorsum to venter on the body, or only to a portion of such a zone. Thus, we are unable to say, whether the temporal area on the scalp represents the supply of a segment in the cephalic nervous system equivalent to the seventh dorsal area on the body; or whether the temporal maxillary and naso-labial must be combined to produce the homologue of a complete sensory band on the body." The import of these valuable researches has yet to be determined in reference to

* "Brain," 1893, 1894.

the insane, and possibly such an investigation may be attended by unforeseen results.

Perversions of the Muscular Sense. — Cramer* divides hallucinations of the muscular sense into three categories according as they occur in connection with the locomotor apparatus, the apparatus of speech, or the muscles of the eye. He assumes the existence of a muscular sense, through which the impressions of accomplished muscular movements are conveyed to the brain. As regards the first of these categories, the fact, that a false or deficient impression of the position of the body or limbs may cause the patient to assume strange positions in order to redress or obviate them, is insufficient, for we know that deranged sensations, which have no connection with the muscular sense, may give rise to the same conditions. Cramer believes, with others, that the acquisition and realisation of speech is made through the muscular sense. Thinking is speaking without voice. When thought is lively, there is a slight nervous impulse transmitted to the muscles of the motor apparatus, which causes involuntary muttering or an irresistible desire to emit words. In considering hallucinations of the muscular sense in the oculo-motor muscles he endeavours to show how our ideas of size and direction, and our conception of motions, are connected with movements of the eyes, of whose nature and quickness we are informed through the muscular sense. These sensations are thought to be blended with those of touch and the movements of the body to form the essential outcome of a single act of perception. The theory that involuntary motions, constrained positions, involuntary actions, and impulsive utterances, and, perhaps, some forms of hallucinations or illusions of sight, are all owing to hallucinations of the muscular sense, is by no means proved, nor does Cramer always make it clear that these symptoms can be so explained. Ireland† has pointed out that the impulse to speak or mutter may arise from a central, instead of a peripheral irritation, and in cases where people hear different voices in the right and left ear, one

* "Die Hallucinationen in Muskelsinn bei Geisles Kranken," Freiburg (Baden), 1889.

† "Journ. Ment. Science," 1891, p. 610.

would be disposed to think that the starting point was irritation of the auditory nerves or auditory centres. He believes, however, that it may be admitted, that in the acute form of paranoia the whole nervous system is in a state of extreme excitement, and that there may be hallucinations both of the muscular sense and of other sensory nerves, as well as motor incitations to the muscles of the voice.

Klinke * agrees with Cramer's explanation, and believes that abnormal sensations in the tongue and throat may arouse delusive fancies leading to derangements of speech. Sometimes these take the form of babbling and childish sounds, or the patient complains of distress and difficulty in speaking, accompanied by a feeling of constriction in the tongue or throat. The muscular sense is said to be *increased* in somnambulistic and hypnotic states. The condition known as *anxietas tibiarum*, in which there is a painful condition of unrest leading to continued change in position of the limbs, is considered to be due to abnormal increase of the muscular sense. *Diminution* occurs in some choreic and ataxic persons.

The *sense of movement (kinæsthesis)* has received so much attention, and there are so many differences of opinion with regard to it, that we must, before concluding this chapter, review in brief some of the leading discussions. Bastian believes, that impressions of various kinds combine for the perfection of this sense of movement, and that in part its cerebral seat coincides with that of the sense of touch. He includes under this "sense of movement," as its several components, *(a)* a set of conscious impressions of various degrees of definiteness—viz., cutaneous impressions, impressions from muscles and other deep textures of the limbs (such as fasciæ, tendons, and articular surfaces); and, in addition, *(b)* a set of "unfelt" impressions, which guide the motor activity of the brain by the information (unconscious) which they afford as to the different degrees of contraction of all the muscles concerned in the production of any given movement. "The occurrence of movement is for the kinæsthetic sense what the presentation of an external object is to the visual sense; and the inability to cognise the impressions occasioned by movement (either those that are conscious, or

* "Allgemeine Zeitschrift für Psychiatrie," xlviii. Band, 1 and 2 Heft.

those that are unconscious, or both), which is sometimes produced by certain morbid conditions of the spinal cord or of the brain, is a defect of the kinæsthetic sense altogether analogous to amblyopia or blindness in relation to the visual sense." * The relation of the kinæsthetic sense to volition will be discussed later. Here we have to consider only those elements which go to make up the so-called kinæsthetic sensations, and the first question we have to ask is, Do cutaneous impressions—impressions from muscles and other deep textures of the limb (fasciæ, tendons, etc.)—actually exist; and, if so, are they all essential to the formation of a kinæsthetic percept? That cutaneous impressions and impressions from articular surfaces do exist there can be no doubt. Duchenne † has pointed out, that in patients with cutaneous anæsthesia of a limb, the muscles of which are not sensitive to faradic stimulation, there may still be preserved a very accurate sense of the way in which the limb may be flexed or extended by the hand of another. Eulenberg ‡ assumes that the articular surfaces are the seat of the perception of movement. The sense of movement may be impaired when the tactile sensibility is preserved. James points out, that the pretended feeling of outgoing innervation obviously plays no part in these cases, from the fact that the movements by which the limb changes its position are passive ones, imprinted on it by the experimenting physician. That the joint surfaces are sensitive appears evident, according to James, from the fact, that in inflammation they become the seat of excruciating pains, and from the perception by everyone who lifts weights or presses against resistance, that every increase of force opposing him betrays itself to his consciousness principally by the starting-out of new feelings or the increase of old ones in or about the joint.§ Lewinski ‖ records the instance of a patient, the inner half of whose leg was anæsthetic. On standing up the patient had a curious illusion that he was knock-kneed, which disappeared the moment he lay down

* "Paralyses: Cerebral, Bulbar, and Spinal," p. 108.

† "Electrisation Localisée," pp. 727, 770, Leyden; Virchow's "Archiv," 1869, Bd. xlvii.

‡ "Lehrb. d. Nervenkrankheiten" (Berlin), 1878, 1, 3.

§ "Principles of Psychology," vol. ii. p. 191.

‖ "Ueber den Kraftsinn."—"Virchow's Archiv," Bd. lxxvii. 134.

again. In this case the inner half of the joint probably shared the insensibility of the corresponding part of the skin, and the feeling was just what he would get were his legs forced into a knock-kneed attitude—*i.e.*, the outer-joint surfaces would be more strongly pressed together than the inner. Lewinski also found in every instance that, when the toes of certain ataxic patients with imperfect sense of position were flexed and *drawn upon* simultaneously with the separation of the joint surfaces, all sense of the amount of flexion disappeared. On the contrary, when he pressed a toe *in* whilst flexing it, the patient's appreciation of the amount of flexion was much improved, evidently because the artificial increase of articular pressure made up for the pathological insensibility of the parts.* Goldscheider † has proved by a series of experiments, that the joint surfaces, and these alone, are the starting point of the impressions by which the movements of our members are immediately perceived.

Goldscheider caused his fingers, arms, and legs to be passively rotated upon their various joints in a mechanical apparatus which registered both the velocity of movement impressed and the amount of angular rotation. No active muscular contraction took place. The minimal amounts of rotation felt were in all cases surprisingly small, being much less than a single angular degree in all the joints, except those of the fingers. The point of application of the force which rotated the limb made no difference in the result. Rotations round the hip-joint, for example, were as delicately felt when the leg was hung by the heel as when it was hung by the thigh whilst the movements were performed. Anæsthesia of the skin, produced by induction-currents, also had no disturbing effect on the perception; nor did the various degrees of pressure of the moving force upon the skin affect it. It became, in fact, all the more distinct in proportion as the concomitant pressure-feelings were eliminated by artificial anæsthesia. When the joints themselves, however, were made artificially anæsthetic, the perception of the movement grew obtuse, and the angular rotations had to be much increased before they were perceptible. ‡

* Quoted from James, "Principles of Psychology," p. 192.

† "Archiv. f. Anat. u. Physiologie," 1889, pp. 369, 540.

‡ James, "Principles of Psychology," p. 192.

The disorders of the sense of movement, as met with in the insane, are possibly to be explained as originating from the conditions of the general sensibility, and more particularly of the articular surfaces. Thus, general paralytics who say they have walked millions of miles (hyperkinæsthesia), or who feel that they are treading on air, have probably some change in the sensibility of the articular surfaces, which act in reality as predisposing factors of illusory states. The sensations of flying through the air, of extreme buoyancy, or of having leaden limbs, difficult movements, etc., may all be explained from this point of view. Those abnormal subjective sensations, however, in which the body or limbs appear to shrink or expand, would be better explained as modifications of the cutaneous and general sensibility. The considerations of the "unfelt" impressions, which are said to guide the motor activity of the brain, we leave to a subsequent chapter. It only remains for us now to add that, in accepting the term kinæsthesis, we simply accept it as designating the sense of movement, and we do not attribute to the muscular elements themselves any part in the production of that kinæsthesis, except in so far as they by their action affect the articular surfaces.

Illusions and Hallucinations in Dreams.—The condition known as the *Hypnagogic* state occurs when an individual is neither awake nor fully asleep. During this period the senses become more or less inactive, except the sense of hearing, which is the most persistent. The reflex activity of the spinal cord is at first somewhat exalted, owing to its being released in considerable measure from the control of the brain. As sleep becomes more profound the reflex functions of the cord are also weakened.* It is thought that, as the sensory organs retire from action, the intellectual faculties lose their equilibrium. First the power of volition ceases, then the logical association of ideas comes to an end, the reasoning faculty disappears, and judgment is suspended. We become, therefore, no longer capable of surprise or astonishment at the vagaries of memory and of imagination—the only faculties that remain in action. To their more or less unfettered activity we owe the presence in consciousness of those disorderly pictures which, occurring in

* Rosenbach, "Zeitschr. f. Klin. Med.," 1881. "Brain," vol. iv. p. 138.

this stage of imperfect sleep, have been termed hypnagogic hallucinations.* The following diagram, borrowed by Lyman from the "Dictionnaire Encyclopédique des Sciences Médicales," gives some idea of the successive phases during sleep :—

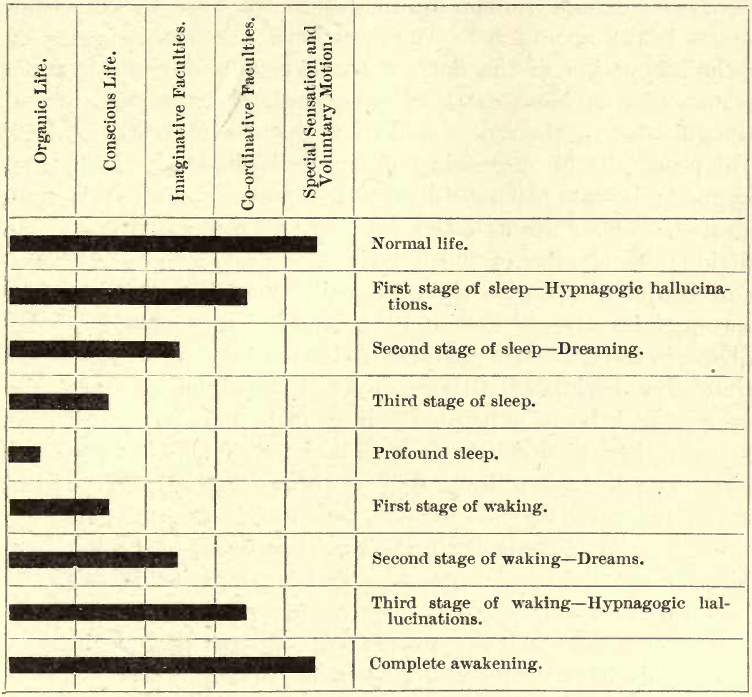

FIG. 16.

Hypnagogic Illusions and Hallucinations.—During sleep, when the subject matter supplied for the exercise of the faculties of perception and judgment, and the operations of the will, are withdrawn, the ideas that still arise are chiefly dependent for their origin and association upon the automatic and endogenous activities of the brain. Undisturbed by impulses from the external world, the brain seems then to become more sensitive to impressions having their origin within the body. An overloaded stomach, an enfeebled heart, a turgid sexual apparatus, or an irritable nervous ganglion, may be-

* Alfred Maury, "Le Sommeil et les Rêves," chap. IV. Quoted from Lyman, "Insomnia," p. 3.

come the source of irregular and uncompensated impulses which, without disturbing the organs of special sense, may invade the cerebral cortex, and may there set in motion a whole battery of mechanisms, whose influence upon consciousness would remain quite unnoticed were the external senses in full operation.* The same author defines a dream as "the occupation of the field of consciousness during sleep by a succession of ideas more or less completely withdrawn from the guidance of the senses and from the control of the will." The possibility of suggesting to an individual who is in the hypnagogic state the nature of a dream has been often demonstrated. Thus, through the rustling of a newspaper an individual has dreamt of the sounds of waves on the sea shore, and conjured up with vivid intensity the visual picture and accompaniments. Sometimes the impression produced by the dream is so vivid that a belief in its reality exists even some time after waking. Baillarger dreamed one night, that a certain person had been appointed editor of a newspaper; in the morning he believed it to be true, and mentioned it to several persons, who were interested to hear it; the effect of the dream persisted all the forenoon, as strongly as that of a real sensation; at last, about three o'clock, as he was stepping into his carriage, the illusion passed off; he comprehended that he had been dreaming.†

The step between the phenomena of dreams and those of insanity is but a very short one; in fact, many of these phenomena are identical in every respect. There is in both a partial displacement of the ego; by which the "I" which perceives the abnormal is not the "I" which was wont to perceive the normal. In artificially induced states of unconsciousness (*e.g.*, by chloroform) the writer has seen an insane patient who, whilst under the anæsthetic, gave vent by speech to the same delusions and the same train of ideas as when in his ordinary state of insanity. This fact alone was significant that the ego bore a corresponding relationship to the actual cerebral activities in both states. According to Lyman, most dreams are composed of visual images. The dreamer looks upon a picture

* Lyman, op. cit., p. 118.

† Taine, "On Intelligence," p. 61. Quoted from Lyman, op. cit., p. 126.

which changes silently before his eyes, without appealing to any other sense than that of sight. But in certain cases any other sense may become excited, producing illusions or hallucinations as perfect as the images of healthy vision. They may be suggested by external impressions, or they may, at least apparently, find their starting point in accidental states of the bodily organisation. All unusual modes of dreaming, and all extraordinary vividness of dream-impressions can be connected with some departure from the physiological conditions of quiet sleep. Either disease, or exhaustion, or emotional disturbance, or narcotic intoxication of the brain may be noted as the immediate cause of such derangement of the cerebral functions.* Maury† states that the ease with which dreams are recollected varies inversely with the depth of the sleep in which they occur. That the mind can solve problems, and perform various intellectual operations in its dream-states is a matter of common observation. The writer has on several occasions drawn upon his hypnagogic hallucinations for melodies and other musical ideas. The question of foresight, or actual clairvoyance, cannot be discussed here.

The physiological basis of sleep is still a matter of uncertainty. It is assumed by most observers that there is at least a partial anæmia of the cerebral cortex. Ziehen believes that in sleep the initial element of the psychical process—the sensation—is produced by "ideational stimulation;" and that the final element—the motor idea or the action—is almost entirely omitted. "The muscular system seems to be lamed; even in the deepest sleep the phenomena accompanying the activity of the tendons, otherwise so accurate an index of the existing muscular tone, have disappeared." That motor ideas do occur in our dreams must be manifest to every one.

In the fully-awake person the judgment perceives the nature of the events which are manifested to the mind; in sleep, and in insanity, on the other hand, the judgment is weak, and there is inability to perceive the absurdity and impossibility of the events which appear to happen. One point in which the dream-state differs from the insane state is to be found in the fact, that, in the former a large part of the

* Lyman, op. cit., p. 131.

† Op. cit., p. 219, *et seq.*

memory is blotted out, and the mind is unable to compare present facts with the experiences of the past; whilst in the insane the memory for remote events is often unimpaired. Hack Tuke* points out a striking characteristic of the dreamer's mental attitude—he is usually free from the nervousness, or lack of courage, or dread of the opinion of others from which he may suffer during the waking-state. "There is an extraordinary change in the personality of the dreamer, to whom the loss of personal identity ceases to be strange, and he passes into the mind and body of the most opposite and improbable characters, without any sense of surprise or embarrassment."

In the insane the dreams are often morbid exaggerations of the waking-thoughts. The writer has observed many instances in which insane persons have dreamt that they had the usual forms of sensory persecution during sleep as during the wide-awake state. Hack Tuke records the case of a lady, the subject of melancholia, who was entirely free from her troubles during the night. It is not uncommon to meet with cases of insanity which have been an actual continuation of the hypnagogic state. Thus, in puerperal insanity we sometimes find that the attack has commenced with a particularly vivid dream occurring in the early morning. In a similar manner an insane hallucinatory condition may be determined by the administration of an anæsthetic, such as ether or chloroform.

* "Dictionary of Psychological Medicine," p. 413.

CHAPTER X.

MENTAL PROCESSES.

Attention.

Definition—Psycho-Physical Process of Attention—Psychical Theory of Attention—The Neural Processes in Attention—Monoïdeism—Polyïdeism—Reflex Attention—Voluntary Attention—Adjustment of Attention—Attention and Genius—Morbid Conditions—Hyper-attention—Inattention—In Mental Disorders.

Conception.

Definition—Concept—Psychological View—Psycho-Physical Theories of Conception—Physiological Theories—Association—Double Nature of Brain—Consciousness the Accompaniment of Nerve Action—The Theories of Discharge and Resistance.

Judgment.

Definition—Degree of Perfection of Judgments—False Inductions—False Deduction—The Perception of Reality—Belief—The Insanity of Doubt.

Imagination.

Definition—Differences between After-Images and Imagination-Images—The Neural Process of Imagination—Morbid Conditions—Simple Delusional States—Sensory Types—Emotional or Affective Types—Clinical Considerations.

ATTENTION.

Before taking up the subjects of "conception" and "association" it is advisable that we should understand a little more clearly what is meant by *attention*. Attention is one of the most important of our mental activities, since a mental fact only exists for us in so far as we attend to it. Sully defines it as "the active self-direction of the mind to any object which presents itself to it at the moment." In accepting this definition it is necessary, however, that the student should recognise that the mind's consciousness of what is presented to it is not always the result of active self-direction. When we attend to a thing we intensify our consciousness by narrowing or concentrating it on some definite and restricted area; but were all our impressions determined only by the *active* self-direction of attention the mind would no longer be the *passive* recipient of impressions from without, and all our mental states would be determined by the primary and voluntary activity of the mind. When we force our minds in a particular direction, so as to make the objects as distinct as possible, the action involves a sense of effort self-determined; but an unusual or novel stimulus may affect our consciousness quite apart from any voluntary effort of attention. In the latter condition the attention is termed *reflex*, and it may even necessitate a strong effort of will on our part to disengage it from the object which holds it. In the struggle for existence among stimuli the attention (or the result) is determined by the intensity or the distinctness of the sensations derived from the stimuli. It is assumed that the more intense material processes accompanying the stronger sensations possess a far greater capability for awakening the images of memory, and determining the course of ideation, than those which are indistinct, confused, and wanting in intensity. Ziehen believes that this also explains why only the object situated in the centre of the field of vision generally determines the association of ideas, and it is just this object that produces the most intense and distinct sensation. "No apperception exercises any arbitrary control over the process whatever." Outside the regions of central focus of the attention there is always a realm of obscure or sub-conscious mental phenomena. How far this region extends in relation to the organism and its processes we are not prepared to say; nor do we know to what extent it is modified by past psychical activities. With every mental act there is a zone or halo of obscure and transitory phenomena surrounding the object which calls forth that act. Wundt says the whole mental region (conscious or subconscious) answers to the total field of view present to the eye in varying degrees of distinctness at any moment when the organ is fixed in a certain direction; the latter region—

that of attention or clear consciousness—corresponds to that narrow area of "perfect vision" on which the glance is fixed.

Every sense-impression (external or internal), and every content of consciousness, when viewed by the "mental eye," is an *object* of attention. Thus all the phenomena of cognition, emotion, or volition may become the objects of attention.

The Psycho-Physical Process in Attention.—The majority of neurologists believe that our sensations are determined, not only by peripheral processes of stimulation, but also by a reflex central reaction, which in turn becomes a determining cause of peripheral ingoing currents. That is to say, not only is every psycho-physical process sensory, but also motor. The *ego* is regarded as entirely dependent on the sensations which are presented to it, primarily through the senses, or secondarily through the sensations of movement or reaction. To Fechner, Bain, Wundt, Ferrier, Sully, Bastian, and others, we are indebted for many observations upon this subject.

The *psychical* theories of attention are, that (1) the sensory presentation, or its ideational equivalent, is followed and reinforced by a distinctively active element of attention, a third element of feeling being commonly, if not in all cases, interposed between them—*i.e.*, the factors are, *sensation* and *reaction* and *feeling*. The reaction is regarded by psychologists as being essentially *active*, and involving a certain degree of voluntary attention.* (2) Attention involves *detention* in consciousness and a corresponding rise in vividness, distinctness, or intensity.† (3) Attention is the pure reflex of some sensory presentative process. (4) The direction of the attention involves the residua of previous experience and habitual forms of mental activity (Sully). (5) Attention involves a voluntary or consciously-selective process, which is attended by feelings of mental effort, and the sense of resistance. Wundt has tried to determine the duration of the discrimination time and the volition time in attention ("apperception"). Münsterberg, on the other hand, contends that the whole process is mostly unconscious or sub-

* Sully, "Brain," 1890, p. 148.

† Ribot, "La Psychologie de l'Attention."

conscious, and that there is no room for the discriminative and volitional period.* Sully regards the result of the experiments made in Germany as being the effects of pre-adjustment, and the quasi-unconscious nature of the phenomena as due to the circumstance that the work of attention had been done in advance. Fouillée† also objects to Münsterberg's explanation as inadequate, inasmuch as it is not enough that a representation pre-exists in this obscure form to its clear apprehension to generate in us the feeling of activity. He points out, that just as a very distant and feeble light can approach and increase in intensity without producing that feeling, so a reminiscence, confused at first, can suddenly grow clear without any seeking or effort on our part. "Whenever attention is present we have a feeling of mental *work;* of expenditure of energy." With this latter statement we do not agree. That attention to the contents of consciousness always involves a sense of effort implies the invariable presence of a volitionary force independent of the intrinsic attractiveness or intensity of the sensations. Were we to assume that the imperative ideas of the insane, which thrust themselves upon the individual's attention, involve a distinct feeling of expenditure of energy, we should make an assumption which would be in direct opposition to our experience. Fouillée also believes that attention is always called forth by an emotion or an interest, by pleasure or pain—*i.e.*, the feeling is the first stage, or, rather, "the very ground of attention."

The Neural Process Theories of Attention.—Fechner, Bain, Lewes, and others, support the hypothesis that the motor apparatus would account for the whole process of thought-control. Bain believes that every idea is composed of an element of passive and of muscular sensation. Wundt and Ward both recognise the affinity between muscular and mental exertion. Ferrier believes that attention specially involves the frontal lobes which contain some of the centres for movements of the head and eyes. Wundt postulates, that a centrifugal impulse from the centre of attention, or apperception, passes to the sensorium, and that this impulse is simultaneous and

* "Beiträge zur Experimentellen Psychologie."

† "Brain," 1890, p. 351.

organically conjoined with another centrifugal process of motor innervation issuing from the same region. According to Ziehen * the *feeling* of attention is merely a concomitant phenomenon. The essential objective characteristic of attentive or active sensation, in distinction from the merely passive sensation, is the influence which the former exerts in determining the choice and order of ideas by which it is followed.

In order to simplify this complicated subject we may use a simple diagram. I may be held to represent the subjective aspect of attention as viewed by the *ego* within consciousness; P is the sensory surface of the cortex which presents sensations to I; M is the motor area, from which efferent nerves pass to the motor apparatus.

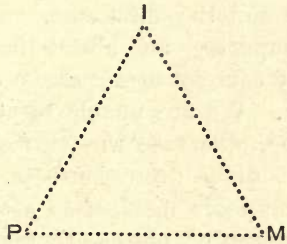

FIG. 17.

(1) Some psychologists hold, that all the phenomena of attention may be determined by the activity of I; (2) others say that P and I are all-sufficient; (3) others that P,I,M, is the order of events; (4) others that M,P,I, occurs; (5) others, again, that M,I,P, is the only solution; while (6) yet others maintain that P,M, or M,P, precede and determine I; lastly (7) others find the solution of the difficulty in the accompanying tone of feeling, or motive which manifests itself at I, and in turn regulates P or M. There will be found room, no doubt, for other modifications and combinations of these theories.

When there is temporary predominance of an intellectual state, or of a group of states, the condition is said to be one of intellectual *monoïdeism*. This condition may arise in a spon-

* Op. cit., p. 209.

taneous, natural, involuntary, reflex, or instinctive manner; or it may be voluntary, active, and artificial. From a popular standpoint, the normal state of the mind is one of polyïdeism. Attention is the momentary inhibition (to the exclusive benefit of a simple state) of this perpetual progression: it is monoïdeism. The sub-conscious states lying outside the limit of attention are regarded as the contents of a diffuse consciousness; and, just as too great a bulk of mere retentions will often impair the process of abstract thought, so diffuse consciousness will tend to impair the process of concentration. We might formulate the law, that the intensity of a state of concentration varies inversely with the diffuseness of consciousness. An over active mind in acute states of mental disorder fails to concentrate its attention in any one given direction, owing to the rapid seriality and the diffuseness of its consciousness. Concentration presupposes an abstraction from other and external objects of consciousness, as is evidenced by intellectual monoïdeism. We are unable to attend to more than one thing at a time, otherwise the two objects tend to pass into the region of diffuse consciousness. "When an equal effort is made, the effective force of an act of attention varies inversely as the extent of object attended to." "The more we comprehend or embrace in the act of attention the less penetrating will it be" (Sully). The degree of attention depends on the quantity of active energy disposable at the time, and the strength of the stimulus, or force which excites the attention or rouses it to action. Stimuli which arouse the attention are divided into external and internal. The external relates to the striking characteristic or attribute of the object which engages the attention; whilst the internal means the motive which prompts the mind to exert its power of attention.

In the insane, the preoccupation of the attention by morbid stimuli often renders the effects of the ordinary internal and external stimuli weak and inefficient. Thus, in the attempt to induce hypnotism where attention is an important factor, failure may be due to one of three causes—viz.: (*a*) In states of diffuse consciousness (acute mania, etc.) great difficulty is experienced in the attempt to reduce the mental states from their consideration of the general to the particular; (*b*) in states of limited consciousness, or monoïdeism, the consciousness is already so far reduced from the general to the particular, that the reduction itself acts as a deterrent to the alteration of the nature of that particular; (*c*) in states of anergia or defective energisation (stupor, exhaustion, etc.) the active or volitional aspect is impaired, and there is failure in the transmission of outward motor and inward sensory currents.

Reflex Attention.—The mere force of the characteristics of the object presented to consciousness is enough to determine the direction of the attention. In the struggle for existence among stimuli, the greatest, the most interesting, and the most novel tend to survive. As a rule, each survival is momentary, and it is characteristic of reflex attention that new stimuli can easily divert it. In conditions of morbid excitability the impressions are often of morbid intensity; while, in exhaustive states, there may be lessened activity of the will in determining the direction of the attention.

The *laws of reflex attention* are, according to Sully, determined by:—

1. The *quantity* of stimulus. The attractive force of a stimulus will vary as its quantity, and more particularly as its degree.

2. The *quality* of stimulus. The attractive force of a stimulus depends also upon its quality—*i.e.*, as it is agreeable, disagreeable, or indifferent.

3. The *interest* taken in the object, determined by particular sensibilities, tastes, habits, etc.

4. The absolute and relative impressiveness. The *absolute* impressiveness is determined by the quantity or quality of the object; whilst the *relative* impressiveness is the force which the object owes to its relation to other objects which have preceded it, and to the pre-existing condition of the attention.

5. The *change* of stimulus. All changes, contrasts, or transitions act as exciting agents to the attention. We are only conscious of an impression when we pass to it from an unlike impression. A certain frequency of transition is, therefore, essential to a state of mental wakefulness.

6. The effects of *novelty*. Those objects which are familiar

to us, and often recur to consciousness, do not succeed in rousing the attention with the same degree of force as objects which are novel.

7. *Familiarity* or *interest* often succeeds in arresting the attention. Thus, for example, in visiting a foreign country, familiarity with the events of its history, or knowledge, previously acquired, of its politics or customs, will render every object of more interest. The interest displayed is often an indication of the character of the knowledge of an individual. Volkmann says the absolutely new does not chain the attention. The amount of expectancy or pre-adjustment of the attention often causes a shortening of the process of reception and recognition.

Voluntary Attention.—Voluntary attention has been compared to the process of artificial selection, and reflex attention to that of natural selection. The will is regarded as supplying the internal motives, which may counteract the effects of external stimuli. In this way it supplements the forces of reflex attention. According to Sully, the mind, through an exertion of will, is able to choose the quarter to which to direct its glance, and is no longer at the mercy of the most powerful external forces. Just as we can lead a horse to the water, but cannot make it drink, so we may force the mind to look at an object, but we cannot compel its fixation upon that object unless there be something of prevailing interest about it, which, by its intrinsic attractiveness, succeeds in furthering our efforts. It is utterly impossible to continue to concentrate attention upon any object for more than a few seconds at a time. We can focus our thought for a moment, and adjust our apparatus to further or facilitate the process of concentration; but, in order to keep the object within the field of distinct consciousness, we have to perform a succession of distinct efforts of recall. Let the student focus his attention upon some object near at hand. He will find, that when he first looks intently at the object he notes its character and dimensions; then almost immediately he becomes conscious of objects which occupy the zone of diffuse consciousness outside the field of distinct vision; next he reflects upon the character of the act he is performing, and realises that *he* himself is subjectively contemplating an external object; and, finally, he discovers that his mind has wandered from its original object, and to correct this he again, by voluntary effort, re-adjusts his attention. James points out that it is not an identical object in the psychological sense, but a succession of mutually-related objects forming an identical topic only, upon which the attention is fixed. "No one can possibly attend continuously to an object that does not change." Helmholtz agrees with this view, and believes that we cannot keep our attention steadily fixed upon a certain object when our interest in the object is exhausted; but that we can set ourselves new questions about the object, so that a new interest in it arises, and then the attention will remain riveted. That this is true of sensory states is apparently evident, and we shall find it to be equally true of intellectual states. Thus, we see that with every voluntary act of attention there is involved a distinct sense of effort, and this more especially in its early stages before the habit has been acquired. When there is any falling-off in vigour, through fatigue or disease, the effort is greater, and attended by a greater expenditure of energy. The available quantity of energy determines the extent to which mental exertions may be carried. Beyond this point, protraction of effort involves tension, and, later, strain. Several writers have stated that there is no such thing as over-strain, but very little experience justifies the conclusion that the over-use of the faculty of voluntary direction of effort is productive of certain forms of insanity, and that the mind, just as the body, may be impaired by excessive use of its functions.

The *adjustment* of attention depends upon (1) the characters of the object itself. Impressions of moderate intensity are, in general, more easily attended to than those of very great or very little intensity. Very powerful impressions in general require a greater effort of adjustment than moderate ones. Very feeble ones require a greater effort also, but for a different reason—namely, in order to raise them above the limit of distinct consciousness (Sully); (2) it depends upon the preceding state and direction of activity of the attention—*e.g.*, in preoccupied states; and (3) upon the ability to arouse the attention by an internal or volitional act—*e.g.*, in conditions of somnolescence, where there is lethargy or inattentiveness, there is also impaired power, or complete inactivity. Exercise strengthens the power of attention, and the growth of voluntary attention is to be acquired by practice. Often we can gain an insight into the will-power of an individual by observing the effects of the solicitations of powerful stimuli as opposed to his power of attention. Thus, one has only to observe the respective attitudes of students who are attending a clinical lecture on insanity to satisfy oneself as to which individuals are possessed with a desire to learn, and have the power of resisting the solicitations of unusual stimuli emanating from the patients near at hand. In general, the junior student pays less attention to the lecturer than to the extraneous influences around him; whilst the adult, or post-graduate, is all-attention, and concentrates his thoughts upon the subject-matter of the lecture. This power, however, has its limits, and it is often impossible to resist the solicitations of powerful stimuli. In maniacal states there is little or no resistance to the various stimuli, and it is difficult to gain the attention. The growth of voluntary attention means a continual reduction of the difficulty of attending to objects. According to Sully, when an intellectual impulse of curiosity is wide and impartial, embracing all kinds of subject-matter, we have the versatile mind, ever ready to turn its attention in a new and unexplored quarter.

Attention and Genius.—Genius, according to Sully, is nothing but a continued attention, and great intellectual power turns on the ability to concentrate the attention. James * says it is genius which makes men attentive, and not their attention which makes geniuses of them. Helvetius regarded genius as nothing but a continued attention ; Buffon as only a protracted patience ; Cuvier as the patience of a sound intellect ; Chesterfield as the power of applying an attention, steady and undissipated, to a single object. Macaulay regarded genius as subject to the same laws which regulate the production of cotton and molasses ; whilst Hogarth said he knew no such thing as genius—" Genius is nothing but labour and diligence." These views contain something of novelty, but continued attention more often enables genius to manifest itself than to create itself. Moreover, it is just this power of continued attention

* "Principles of Psychology," vol. i. p. 423.

which genius often lacks. Subsequently we shall see that attention is a most important factor in the formation of all our conceptions, and in the assimilation of impressions which can be recalled by memory. We can conceive, that forms of attention which involve no voluntary effort, but are apparently derived from the initiative of the object, may be results rather than causes; but when we attempt to reduce voluntary efforts to the same platform, we get beyond our depth, and enter upon the discussion of matters which are not to be decided arbitrarily by us, either as physiologists or psychologists. Whichever way we look at this subject we cannot but realise the fact that, until we are able to determine what the agent is which sustains the phenomena of consciousness, we are groping in pitchy darkness. We offer no theories, nor abstruse philosophical doctrines of the existence of an immaterial agent which determines the order of events by its own inherent laws. In fact, we cannot conceive the existence of such a substantive factor independent of its neural agency. All that we can conceive is, that the *vera causa* of mind is to us unknowable.

Morbid Conditions of Attention.—From the preceding considerations upon the conditions of attention, it will be readily understood how variations may arise in the sane. In the insane we see the more strongly marked or diminished forms of attention. The term "hypertrophy" (Ribot) has been employed to signify an exaggerated form, but we prefer to use the term "hyperattention."

Hyperattention.—By this is meant morbid exaggeration or excessive concentration of the attention; or, in other words, reduction of the general with exaltation of the particular. Normal mind is polyïdeational. When there is a predominance of an intellectual state, or group of states, to the exclusion or defection of other states, the individual is in the condition generally known as being "mad on a subject." Hyperattentive states are thus meant to signify states of monoïdeism, or states in which the reduction has lapsed from general intellectual activity to concentration upon a fixed idea. As an intensification or combination of such a condition, we have delusional states, as seen in the insane.

Hyperattention may be regarded as invariably tending towards the insane state. Clinically, we may classify the results of hyperattention as follows :—

1. Simple fixed ideas—purely intellectual.
    (*a*) Ideas of greatness.
    (*b*) Unfounded suspicions.
    (*c*) Unseen agencies.
2. Fixed ideas accompanied by emotion.
    (*a*) States of depression.
    (*b*) States of exaltation.
    (*c*) States of ecstasy.
3. Fixed ideas, with motor activity.
    (*a*) Irresistible tendencies which manifest themselves in violence or criminal acts.
4. Fixed ideas, or oft-recurring imperative ideas.

We shall speak more particularly of all these forms later, so we now pass to the condition known as "inattention."

Inattention.—In the sum total of our conscious existence there are numberless dim, ill-defined, sub-conscious impressions, which have never been illuminated by the mind's attention. Helmholtz has formulated the law, that we leave all impressions unnoticed which are valueless to us as signs by which to discriminate things. Were this otherwise, no continuity of thought would be possible; the mind would act like a weather-cock, which turns with every breath of wind. Sometimes the determined effort to concentrate the attention upon an object only results in fixation of the apparatus; the mind itself pays more attention to the adjustment than the object itself. Some individuals, on the other hand, can only resist extraneous stimuli by keeping the motor apparatus in action —*e.g.*, as in pacing the room. This fact has suggested to James, that the activity drains away nerve-currents, which, if pent up within the thought-centres, would very likely make the confusion there worse. He offers the suggestion that it may also be a means of drafting off all the irrelevant sensations of the moment, and so keeping the attention more exclusively concentrated upon its inner task. Every individual has some characteristic and habitual activity of this sort. One writer is unable to work without the presence of a pipe in his mouth; that there is no tobacco in it is immaterial. James also suggests, that a downward nerve-path is thus kept constantly open during concentrated thought; that incidental stimuli tend to discharge through paths that are already discharging, rather than through others; and that the whole arrangement might protect the thought-centres from interference from without.

In the insane, inattention is frequently seen in the individual who has abnormal rapidity and exuberance of ideas, so that no particular state of consciousness lasts even for a moment, as in the case of delirium or of acute maniacal states. In another class of cases there is absence or diminution of the power of inhibiting the solicitations of other stimuli—*e.g.*, in hysteria, irritable weakness, convalescence, intoxication, extreme states of bodily and mental fatigue, and in apathetic and insensible individuals.

From what we have already said about conditions of hyperattention the student will be able to appreciate the general law, that when the attention is engaged with the contemplation of the mind's own contents or ideas there is a corresponding diminution in its reactionary power to extraneous influences—*i.e.*, present-mindedness varies inversely with so-called absent-mindedness. Thus, in the melancholiac, the hypochondriac, the "faddist," or the deluded maniac, the presence of a dominant idea is sufficient to give rise to various degrees of inattention to stimuli from without.

To those who work among idiots or imbeciles the element of attention is one of the most difficult questions with which to grapple, and it is to such workers that the importance of attention in the development of mind becomes most clearly evident.

In insanity, we may say, that in states of depression there is a tendency to subjective hyperattention, with a corresponding ratio of inattention to objective stimuli. In states of mental exaltation there is subjective inattention and a corresponding variation in objective attention, or hyperattention; in states of mental enfeeblement there may be absence of the power of attention to events both within and without; whilst in delusional states there may be hyperattention to events within or without, with or without a corresponding amount of inattention to events without or within respectively.

The power of transition of the attention is a feature worthy of careful observation in the melancholiac and the maniac. In the former, it is held by some dominant idea, and before we can divert it to external events we may have to resort to other stimuli. Thus, in some cases it is impossible to gain even a reply to a simple question without the aid of an additional stimulus—*e.g.*, a pull on the hand or arm; whereas, in the maniac, the transition from one external object to another is so rapid that the speech is incoherent in its inability to follow and give expression to what the mind attends to, and the very rapidity of the reaction to external stimuli prevents the formation of any subjective idea other than what is merely transitory. In other words, we may say that in maniacal states the consciousness is diffuse; in melancholia, there is a tendency to internal concentration, or to reduction from the general to the particular; in delusional states the reduction is still greater; while in degenerative states the consciousness is confused. In maniacal states the attention is essentially reflex and fleeting; while in melancholic and delusional states it is more concentrated and of longer duration, and in the latter more liable to be fixed.

CONCEPTION.

The possession of a conscious intellect, and the power of reasoning by general notions raises man above every other creature on the earth. Everything great in science, art, or literature is the work of intellect. Of the threefold division of mental operations adopted by mental science—knowing, feeling, and willing—that of knowing includes, the operations by which we recognise what is present to the senses, the act of recalling former cognitions, and the processes of reasoning. The psychologist differs from the logician, in that the former has to do with the *usual* modes of thought, whilst the latter has to do with the *right* modes of thought.

A *concept*, notion, or general idea, is the representation in our minds answering to a general name—*e.g.*, soldier, man, animal. All thinking implies comparison of one object with another. We recall, group, and arrange the cognitions gained by former perceptive processes, and retained by memory. The stages of thinking are: (1) The formation of general concepts, which constitute the elements of thought—*e.g.*, the recognition of a body as material; (2) the combination of two concepts in the form of a statement = judgment—*e.g.*, material bodies have weight; (3) the process of drawing an inference or conclusion = reasoning—*e.g.*, gases are material substances, therefore gases have weight.* Concepts are formed (1) by *comparison* of the objects presented, or of those called up by the representative imagination; (2) by *abstraction*, which implies the action of attention (a passive reception of impressions with a comparatively feeble action of abstraction results in a want of clearness, or an imperfection in the concept); (3) by *generalising* the objects compared.

Concepts may be wanting in distinctness when their elements are not distinctly represented.

The concept must also be distinct from a somewhat similar concept, otherwise it tends to become indistinct. Thus, there is a vast difference between the conception of a "form of epilepsy" and an "epileptiform" condition. A fish may perform whaliform movements without being a kind of a whale. Our notions can only be clear when we recognise the things which correspond to them; when we do not do this they are necessarily obscure and ill-defined. A notion is distinct when its several parts are distinctly represented; otherwise it is indistinct or confused.† The tendency in mental disease is for notions to become indistinct from the lapse of memory; and the organic unity of a concept is thus apt to be weakened. Its associations are dissolved or disintegrated. The common characters of the representation become hazy and indistinct. In this manner, says Sully, the concept tends by lapse of time to return to its early crude state of a string of images, or an imperfectly combined mass of images. Inaccuracy of concep-

* "Sully, "Outlines of Psychology," p. 339.

† Hamilton, "Lectures on Logic."

tions may arise in the same way as mere indistinctness. When we take too narrow, or too wide a view of things, the result is imperfect abstraction and a resulting inaccuracy of the notions.

Defective conception, at the outset, often leads to greater inaccuracy through imperfect revision. In this way crude or imperfect concepts frequently evolve into false notions by revision. In many individuals there is a constant tendency to widening of the notions, so that ultimately they embrace too much; whilst in others there is a tendency to specialise, or reduce too much to the special—*e.g.*, as seen in the growth of monoïdeistic states. Frequently, as the result of specialisation, there is developed a tendency to individualise or to apply notions to the personality—*e.g.*, in the various writers who have "fads" and endeavour to assert their individuality synonymously with the fad. We all vary in our conceptual power and in the power of abstraction. Some individuals are facile in the detection of similarity and diversity, others gather and retain a great bulk of conceptions but are unable to abstract from them. In the uneducated classes, generally, the power of retaining concrete conceptions is often greater than in the educated, who deal largely with the abstract. Some individuals can only form abstract notions in connection with their special line of thought. The mental physiologist may be deficient in framing wide concepts as to physical formulæ, or ideal notions of the mathematics of mind; or, on the other hand, he may lack the philosophic power of abstracting and thinking about the subjective side of mental phenomena. It is not uncommon to meet with a logician who has at his finger tips, as it were, all the formulæ of how we *ought* to think, but who professes utter ignorance and incredulity about the ways we *do* think.

In the true economic management of brain-power a certain amount of attention to the concrete must always precede abstraction—*i.e.*, we must proceed from the consideration of the particular to the general. The abstract notion must be fed, so to speak, by the concrete perceptions, by memory, and by the reproductive imagination.

From a psychological point of view, therefore, we see that morbid conditions may arise as individuals vary (1) in their sensory discrimination, perceptual power, and in their conceptual power and assimilation : (2) in their power of attention and abstraction (some individuals possess very high theological views derived from tradition, who, nevertheless, have defective power of introspection, or of forming abstract notions for themselves) ; (3) in the amount of attention given to the concrete (in the uneducated and in the weakminded attention to the trivial events of life gives the sum total of their mental being ; similarly, some plodders who devote all their energies to the contemplation of the concrete neither see nor think beyond their microscopic region of central focus). In acute mental disorders the rapidity of formation of notions, the defective conditions of the memory, and the pranks played by the imagination are predominant factors. In subjective and introspective states the slowness of the processes, and the persistence of the direction of the attention to the false conceptual series, aid, in great measure, in the formation of the narrow egoistic states, or the delusional series.

The arguments of some psychologists, that conceptions develop themselves, and that a "judgment" is due to the self-massing of present and previously acquired notions, are incomprehensible. The original conception remains what it always was. The mind can form a new conception which it can compare with the old, but it cannot modify the old so as at the same time to obliterate it. Every conceptual act is either a new combination formed by the mind itself, or rather a new combination viewed by the mind as such; or it is a reproduction of a former conception in its perfect form, or in its somewhat indistinct state owing to the lapse of memory.

Conceptions are unchangeable. The new cannot displace the old—*i.e.*, every conception must always remain in the sum what it was originally. They will ever remain as distinct, and as definitely apart from each other, as the first and the subsequent enlarged or revised editions of a book. To the student who thinks of *how* we think and what our thought comprises, the conviction must force itself upon him that the power of abstraction is a function of the mind which will never come within the province of logical or physical explanation. The fact that we do think about and abstract from what our organism presents to us, requires no proof. James has proved that nothing can be conceived twice over without being conceived in entirely different states of mind. When we look upon a familiar face the present view is not an exact copy of the former views. When we read a book several times, each time we read it the mind sees something new. No idea which is conjured up by the context is the exact counterpart of the former ideas. To continue along one line of thought, or to make the mind dwell upon one conception is impossible; we can revert to it, possibly at will, but each time we do so the thought is in itself a new conception bearing a resemblance to the old.

The Psycho-Physical Theories of Conception.—It is supposed that, with the first transmission of the physiological force, whereby the impression of an external object is presented to consciousness, a trace of the cortical excitation that has taken place is left in the cerebral cortex. This conclusion is arrived at from the fact that former presentations can be reproduced by memory. These images of memory or mental images which are deposited by each sensation are designated as ideas.* The images of memory or ideas are held to be quite different qualitatively from the actual sensations themselves. The process which takes place when a sensation disappears and its image is deposited in memory, is supposed to be some sort of material change which remains as a trace or sign, the cerebral cortex never fully returning to its previous condition. With the deposition of the image there is no concomitant psychical process whatever. According to Ziehen this is accomplished latently, without our being conscious of it. "There is no psychical element left of the sensory excitation corresponding to the sensation, but only a permanent material change . . . . the remanent material trace has no psychical correlate whatever." He further conceives that this material trace is a definite arrangement and constitution of the molecules composing the ganglion-cells, and that it only becomes psychically active as an image of memory or an idea when the object of the primary presentation again asserts itself, or when, by means of the association of ideas or the play of fantasy, some related idea occurs. "In order that the dormant image of memory, which

* "Vorstellung," Hegel, Lotze, Ziehen, etc.

is as yet only potential, may be aroused, therefore, the ganglion-cell having the disposition El (latent excitation), must first receive a new impulse from a new and similar sensation, or from some related idea with which it is associated—that is, the El must be still further changed in some definite way, becoming an ideational excitation. Hence the ganglion-cell is trained to a certain extent for a definite idea."

Let us now assume with Ziehen, that the ganglion-cell has this greatness thrust upon it. We do not know for certain whether the cells or only their processes are concerned with conscious events, nor do we know which groups of cells are the seats of mnemonic images. This, however, need not detain us. What we have to understand is the power or property of each cell which would correspond to all emergencies. Let us imagine the "seat of memory" to be the library of the British Museum. Every new work or idea is relegated to its proper department and deposited on a shelf, where it remains inert. It is, so far as itself is concerned, a material object only, but contains a large amount of latent thought. In order to set free this latent thought, so that it may be perceived by, say the librarian, the deposit of another somewhat similar book by its side is supposed to be all-sufficient. But, the student will say, in the first instance a knowledge of the contents of the first book is pre-supposed to the librarian, and the addition of another somewhat like it recalls all the contents of the former. Precisely; the librarian represents the mind, he reads the book; the one book does not jostle its contents into the vacuum of an inert mind. The activity rests in the librarian. The one inert mass of latent thought (the book) does not combine with another inert mass so that the two by their own inherent properties evolve a mind in the librarian. The mental activity of the man who shelves the books is all-important; and so is the activity of the mind which reads the sensations and forms associations between the gleanings derived from physiological factors of which we know nothing. How the books arrive at their shelves, and how they are classified, is known to the librarian; but the mind cannot, as yet, grasp how the so-called cortical traces are determined, nor can it form any conception as to their mode of classification.

When I look at the book-shelves of my study, and see in each closed volume the idea of their contents, their action is merely by suggestion, my mind does the rest. So it is with the mind and our cortical structures. Each book may represent a cortical trace, or latent excitation, but it is the mind which realises that excitation, and which turns and contemplates the appeal from each individual book. As with minds, so with librarians. Some appeal incessantly to their cortical traces or books for knowledge, while others are appealed to by those traces or books for the independent summations of an intellect which transcends their contents. To enter upon the question of how far the mind is dependent upon molecular changes for its knowledge of ethical and philosophical systems is not part of our object. All we desire to point out is, that the psycho-physiological theory, as depending upon a purely cellular basis of memory, is insufficient.

The **physiological theory** fares no better than the psycho-physical one. The supposition, that in the case of the visual sense the relations of the retina are to a certain extent reproduced in the visual centre, so that the superior margin of the former corresponds to the anterior margin of the latter, is absolutely without verification. Ziehen states : "To this excitation of numerous ganglion-cells corresponds the visual sensation." We have already discussed the question as to whether sensations and ideas involve the same cortical elements, and we have seen that, from our present knowledge of physiology and pathology, we are justified in the assumption that different cortical elements are involved. It is commonly assumed that the ganglion-cells of the sensory areas transmit their excitation to another ganglion-cell (the "memory-cell") where the molecular counterpart of the visual idea, or proper image of memory, is stored. In order to explain the storing of sensations derived through the different senses whose centres are situated in different parts of the cerebral cortex the following theory is advanced.

From the fact, that disease, injury, or extirpation of certain areas of the cortex is followed by partial defects in the memory, it is assumed that the "images" of memory are deposited in immediate association with these regions. An idea is regarded as a complex psychical state, deriving its component parts from the images deposited in different areas of the brain. Thus, assuming that visual, auditory, olfactory, and motor images are stored in their respective regions, and that they have often been called into activity simultaneously, an idea is supposed to be due to the summation of activities within these regions. That is to say, the component sensory elements are deposited in different parts of the brain, and are connected with each other by associative fibres, so that when one of these areas is excited the others are called into action by association. The idea, therefore, would appear to depend upon the functional integrity of the structures from which the physiological equivalents of its component parts are derived.

In favour of this view we have the facts derived mainly from the study of the various forms of amnesic aphasia. With the absence of certain areas, through injury or disease, the corresponding representative element is also absent in the idea. Moreover, the other physiological elements, which are assumed to be functionally competent, are nevertheless unable to compensate for the loss by their own activity. That is to say, they are unable to supply the mental deficiency. Experimental evidences are abundant to prove that certain sensory areas may be eliminated (so far as we know them anatomically); and with their removal, there is also interference with the material dispositions through which their representations in consciousness would appear to depend.

The seat of transition between sensory stimuli and their mental equivalents, and the seat of the material dispositions which are immediately concerned with the reproduction of these mental equivalents would appear to lie somewhere within the so-called sensory areas. There is scarcely any need for a physical explanation of the summation of the material dispositions which would correspond to the elements derived from the regions of the different senses. Nor do we deem it necessary to surmise that a combination of these material processes occurs in one supreme centre. When once we have grasped the notion that any one percept is the result of a serial analysis of the presentative and representative processes derived from the anatomically distinct sensory areas, and that this psychical associative or serial process is correlated to the physical associative process, the greater part of our difficulties will be surmounted. When we discuss language with its ideas of articulation, and the pathological evidences brought to bear upon the question of the acoustic memory cells, and their relation to the acoustic sensory cells, in those mentally deaf to words, the full significance of this view will become more evident.

Double Brain.—Let us now consider the significance of the double nature of the brain, and the relation which each hemisphere has to the formation of an idea. It is supposed, upon the evidence of pathology, that every component of an idea exists twice in the brain. If there is entity of mental action, how are we to combine the simultaneous processes which go on within the two hemispheres? An explanation has been sought from the analogy of what happens in the case of the eye when there is hemianopia. In this case we know that destruction of both the visual regions is necessary to produce complete blindness. The prevailing theory is, that the impressions of the two objects are combined by the mind into one image, which is a compound of both. Brown-Séquard believes that one hemisphere of the brain is enough for all the processes which initiate mental functions. Most observers, however, believe that the representations on each side of the brain are unequal. Goltz removed one hemisphere in the dog and found that the ordinary actions and habits of the animal were little affected; but when, on the other hand, parts of both hemispheres were removed, the intelligence was markedly affected. Ireland assumes from this, that both halves of the brain have functions closely corresponding; but in man the specialisation of function in one hemisphere has begun. Hughlings-Jackson believes that the right half of the brain is the automatic half, and the left is the half in which automatic action passes into what we call voluntary action. He also believes that when an aphasic patient utters a few words or exclamations it is owing to the action of the uninjured right side of the brain. The estimation of the difference in temperature of the two sides of the head associated with use of one side of the body, has, in the hands of Broca and Fasola, proved that frequently there is a rise in temperature which corresponds with the half of the brain affected. The phenomena of sensations referred from one side to the other, and of bilateral reflexes, are suggestive, but they are so rare, and so many other possibilities enter into their explanation, that for the present they cannot help us. The explanation of the phenomenon of mirror writing is that, in the cases of paralysis of the right arm, the image, or impression, or change in the brain tissue, from which the letters are produced by the hand, was destroyed, and that in trying to write with the left hand the patient wrote from an image on the right side of the brain in every way corresponding, save that it was reversed. Thus, the motions in each case would be centrifugal and corresponding; in the one case the characters would be formed from an image on the left side; in the other from the right side of the brain.* Ireland believes that one side of the brain is sufficient for all the usual functions of the mind and body in daily life. From an examination of a considerable number of instances, in which there was disease or destruction of one or other hemisphere, he concludes that both sides of the brain are functionally active, and, as far as we know, save in a few instances, both sides have the same work to do. Ireland's remarks upon this subject are so comprehensive that we quote them in his own words:—

"We may hold from analogy that, as long as corresponding, or complementary, or congruous impressions are produced in each hemisphere, no disparity of thought or affection will be noticed, just as the same or complementary impressions from both retinæ are fused into one mental image. Double action of the brain is only displayed in health by the capacity of attending to several mental processes at once. It is in diseased action where one side of the brain is affected, and not the other, that we may expect to find a derangement of the harmonious action of both hemispheres. In cases of wounds or injuries of one side of the brain, the following symptoms have been observed: The patient is quite sensible, though perhaps exhibiting signs of distress or restlessness, or twitching of the muscles. When spoken to he will answer for a time composedly; but conversation soon fatigues him, he begins to be anxious, then distressed, and further conversation becomes painful and exhausting. Nevertheless, to outward appearance he is composed and reasonable. The explanation of this is, that one side of the brain being still healthy, it acts in a normal manner, but in the exertion to carry on

* Ireland, "Tuke's Dictionary," p. 399.

a conversation the diseased hemisphere has to carry on parallel actions. The result is the feelings of distress which oblige him to shun or arrest any unusual mental exertion. In such cases it sometimes happens that lying on the diseased side causes a painful feeling, and when the patient during sleep turns upon the affected side he awakes in a fearful dream. Inflammatory processes, implicating the surface of the hemispheres, are liable to spread by means of the membranes which are united at the middle line. We may also suppose that irritation of particular parts of the brain has an effect upon the opposite side, in the same way as inflammations of one eye have an irritating effect upon the sight of the other eye."

The same author believes that the disparity between the weights of the hemispheres in the insane (especially in epileptics and general paralytics) is a proof of the existence of unequal disease of the brain. He endeavours to furnish an explanation of many symptoms in insanity by the assumption that there is one-sided or unequal disease of the hemispheres. Such symptoms he describes as (1) *la folie lucide*, in which, though struggling with delusions and hallucinations, the patient still retains a considerable measure of intellectual clearness and self-control; (2) cases of melancholia, with dislike to being disturbed and intense feelings of misery, but it is found afterwards that he has noted and understood everything round about him; (3) cases in which the patient has struggled with some dominant idea with more or less success; (4) cases in which the patient asserts, that he has become a new person, that spirits or some other beings introduce new thoughts into his mind and incite him to perform motions which he never willed, and of which he disapproved; (5) cases of conflicting volition where the person is at a loss whether to commence a motion on one or other side, or in which he alternately uses the one or the other hand; (6) cases in which the hallucinations differ on the two sides; (7) cases in which the patient feels the intrusive force of a second personality; (8) cases in which the patient seems to obey or receive a delusion, but at the same time disbelieves it, as in those dreams where a person retaining the belief in his own identity witnesses his own death and burial; (9) cases of double-thinking; the subject hears his thoughts repeated into his ear by some strange voices immediately after conception (supposed by some to be due to retardation of one hemisphere); (10) cases of double-consciousness, double-memory, in somnambulism or induced hypnotism (supposed to be due to alternate activity of the hemispheres).

The comprehension of the relative functional activities of the two hemispheres is as yet, however, in its infancy, and we hope that time and research will do much to throw light upon this intricate subject. Before returning to the psychological side of thought, let us look briefly at another theory as to its material side.

Consciousness the Accompaniment of Nerve-Action.—With constant repetitions of a material process the corresponding currents which accompany it are believed to establish, as it were, a right-of-way, or clear line, on which little resistance is experienced. With the establishment of new currents, however, new channels are opened up, and the nerve-elements become united by new bonds. It is held by Mercier, that the newer the nerve-action, the more vivid the conscious accompaniments; hence, he says, it is to this new formation of channels that we have to look for the physical condition of the occurrence of consciousness. He further states, that in a region which has not yet completed its organisation, we find that the cells are less definitely constituted, and that the fibres are far less sharply demarcated from the matter in which they are embedded. So little, indeed, are they differentiated from this substance, that it is often a work of difficulty, of delicacy, and of much labour to establish the difference between them; and the difficulty becomes greater the further the fibres are pursued. This anatomico-physiological hypothesis, that the richness of the cellular association furnishes the explanation of the characteristics of intellect, is very general, and has lately been urged chiefly by Ramón y Cajal. If we accept this hypothesis, however, we are really no nearer the solution of the main question, What is the relation of consciousness to these anatomical tubes or structures?

Whichever way we look at the subject, a thoroughgoing materialistic formula must provide a material accompaniment for every apparent activity of the mind. If one region, above all others, is to be the ultimate substratum of conscious life, then the elements of this substratum must, by their exquisite refinement of structure and incomprehensible versatility of function, provide the mind with all its states, and hold within its material disposition the power of formulating for the mind the infinitesimal number of variations which have been acquired by the experience of a life time. It is held that where a nerve-current passes easily, there is no conscious accompaniment. When the channel is narrowed, however, and the current is unable to pass freely, consciousness appears. Mercier has therefore formulated the law that, "the intensity of consciousness varies as the difficulty which the nerve-current experiences in passing the narrow portion of its channel." Further, he says, "consciousness is an epiphenomenon, and has no community of nature with the nerve-current, whose passage it accompanies." According to this, consciousness would appear to be determined by conditions of mechanical resistance to the flow of currents. If we assume that this is the explanation of consciousness, then we must also assume that consciousness ought to accompany nervous current everywhere; and, unless we can prove that the cerebral cortical currents differ from the peripheral currents, we must locate consciousness everywhere where there is nervous resistance to be overcome and tubes to have their calibre enlarged. We know of no *specific* mode of cerebral action which would correspond more particularly to states of consciousness than the ordinary peripheral currents.

To speak of "waves of force that pass through the grey matter of the cerebrum," "the constitution of the molecules," "their discharge and resistance," "the directions of the poles of the molecules," "the shifting of molecules so as to bring their poles nearer to parallelism," "the permeability of tracts," and the "accession or decompounding of the molecules," conveys in reality no more meaning to us in regard to the cerebrum than it does in regard to any nerve of the body. Moreover, were these hypotheses verified in the department of physics, they would remain as facts belonging to that department, and would have no community with the facts of mind. If the "epiphenomenon" of mind is in intimate relation to the actual area of obstruction, then mind must needs be everywhere; if, however, the mind only becomes aware of these sensations of discharge and resistance from a distance, then its ultimate substratum must either be a mechanical force, which is centrally sensitive to every distant oscillation of molecules directly through its wave of force, or it must become cognisant of the interhappenings of the molecules at a distance through some other channel, in which case another substratum would have to be devised, whereby the knowledge could be transmitted. If we are told to believe that the mind in some mysterious way perceives the internal current, and witnesses its dilating effects upon the small nervous tubes of the cerebrum, in much the same manner as our fingers feel a pulse, then we have to construct a material counterpart of mind which shall correspond to our fingers. "Of what avail are all these objections?" the student will say; "the theories of discharge and resistance are plausible, and serve our imagination better than any others." So long as they serve the imagination only, and do not incorporate themselves as truths known to science; and so long as they do not form traditions which lead to beliefs, no harm is done. Whether the completely differentiated physiological disposition of molecules will ever become a matter of knowledge is a question which we leave to be answered by science. That the acquisition of such knowledge will ever lead to any explanation of the phenomenon of mind itself in its subjective aspects, we do not deem possible. On the subject of abstract conceptions, physiological psychology has little to say. We cannot reduce them either to sensations or to their mental images. When we speak of imagination, we shall take into account the nature of the so-called reflective ideas, and we shall see how far they may be designated as abstract.

JUDGMENT.

Judgment is the act of connecting two representations under the form of a statement. We keep the two representations apart from one another, but at the same time we connect them. Without the element of belief, however, the mere connecting of two representations does not constitute an act of judgment. *Recepts* are spoken of as the first and simplest inferences following continuously upon a concept—*e.g.*, one dog scents another dog.* Romanes termed these *generic*

* James, "Principles of Psychology," vol. ii. p. 327.

ideas, to distinguish them from concepts and general ideas. When we reason, we select the essential qualities and substitute them and their implications for wholes. Thus, in reasoning, the character or quality which has been extracted is taken as equivalent to the entire data from which it comes; hence the extracted character is more general than that of any individual datum, and its connections are more suggestive and familiar to us. Reasoning, therefore, implies the ability to extract characters from given data. It is held by some, that the most elementary simple difference between the human mind and that of brutes lies in the deficiency on the brutes' part to associate ideas by similarity, and to abstract or reason therefrom. In a genius this power is often manifested in an extreme degree.

The degree of perfection of judgments depends on

1. Its *clearness*, and this is interfered with by
   (*a*) Imperfect observation.
   (*b*) Defective conditions of memory.
   (*c*) Imperfect use and conception of words.
   (*d*) The presence of emotional disturbances.
   (*e*) Traditions—attending to the notions of others.
2. Its *accuracy*—interfered with by
   (*a*) Imperfect understanding of propositions.
   (*b*) Imperfect observation.
   (*c*) Imperfect recall.
   (*d*) Emotional states—strong feelings.
   (*e*) Instability of mental action.
   (*f*) Rapidity of formation of judgments.

Judgments may be correct or otherwise in respect of their mode of formation, but, if when formed they are persistent, they may become advantageous or the reverse. Thus, in every branch of science and literature, we note the obstinacy with which erroneous judgments are adhered to, and the obstacles which they thus present to the advance of knowledge. A distinction has been made between *instinctive* and *reasoned* judgments. "A savage," says James, "is often as tactful and astute socially as a trained diplomatist. Women's intuitions, so fine in the sphere of social or personal relations, are seldom good in mechanics. Most boys teach themselves how a clock goes; few girls. Whately says woman is the unreasoning animal, and pokes the fire from on top."

In diseased states, the delusions of women, arrived at by intuitional processes, are seldom capable of correction by logical reasoning. The evolution of the mind in man differs essentially from that in woman. The woman at twenty has often formed her mental character in nearly all its essentials, and this remains through life, or, perchance, begins to develop from the reasoning side at the close of the reproductive period; whereas, in the youth of twenty the reasoning faculty is undergoing active evolution, the mind is developing and endeavouring to assume a shape, is easily moulded, and deals little with intuitions as compared with reasoning.

Morbid developments of the reasoning process may arise by (1) *inductive* processes, as seen in the ideas of self-importance which have arisen gradually from the false interpretations of concrete signs, or the morbid intensification and distortion of concrete facts from imperfect or diseased abstraction; or, by (2) *deductive* processes, whereby an invalid conclusion has become evident in consciousness, and through confusion, want of discriminative power, haste, or emotion, the data cannot be analysed correctly.

The Perception of Reality, Belief.—It is unnecessary for us to point out the difference between imagination and belief in the objective reality of an image. Belief, or the sense of reality, is regarded in its subjective aspects as a sort of feeling or emotion. The condition of doubt is the true opposite of belief; disbelief is as positive a state as belief. Both conditions of belief and doubt may be pathologically exalted. James has it that one of the charms of drunkenness lies in the deepening of the sense of reality, and that this goes to an extreme in nitrous oxide intoxication, in which "a man's soul will sweat with conviction." In various pathological states there is inability to rest in any belief without having it confirmed or explained constantly. This condition may be paroxysmal or chronic. Among the insane we meet with every variety of belief and doubt. We are all apt to believe things real until they have been contradicted. Our beliefs and doubts depend on the fact that different minds vary in their way of looking at things, and that objects do not appear the same to all. To attempt to explain belief from a physiological point of view is a task which we cannot undertake; nor can we describe the apparatus which determines the direction of our thoughts and enables us to adhere to, or disregard the objects of, belief or doubt.

The *insanity of doubt* has received considerable attention at the hands of Falret, Esquirol, Baillarger, Legrand du Saulle, Oscar Berger, Griesinger, Ball, and others. Professor Ball compares the condition to a sort of incorrigible "cerebral pruritus." The cause of the disease is uncertain. Some writers believe that it is one of the forms of an hereditary neurosis. Undoubtedly stress and strain, as in those who are guilty of sexual excesses, or in those who are overworked or worried, may be sufficient to determine the condition. It occurs most frequently among the educated classes, and is commoner in women than in men. Professor Ball believes that it often declares itself at the age of puberty. The disease is not uncommon as a sequel to febrile states, and has been met with in the puerperal state. Moral shocks, sudden frights, and strong emotions are also said to cause it.

The varieties of doubt met with in the insane may be tabulated as follows:—*

Insanity of doubt.
- *Subjective*
  - *Intellectual* .. *Perceptive.* *Mnemonic.* *Logical.*
  - *Emotional* .. *Moral.* *Religious.* *Scrupulous.*
  - *Volitional* .. *Present actions.* *Past actions.* *Right or wrong actions.*
- *Objective*
  - *Metaphysical* .. *Natural laws.* *Religious.*
  - *Scientific.*
  - *The Supernatural.*
  - *The Ordinary* .. *The body and its functions.* *The physical environment.*

* Professor James says that every object we think of is referred to one world or another in our *ego*. These worlds, in which doubts may arise, are: the world (1) of sense (of physical things); (2) of science; (3) of ideal relations; (4) of idols of the tribe; (5) of the supernatural; (6) of individual opinion; and (7) of sheer madness and vagary.

Roughly speaking, our doubts may refer to the mind's own states, or to the objects which are the external counterpart of the mind's states. In the intellectual sphere of mind, doubts may arise as to the accuracy of our perceptions—*i.e.*, every presentation of sense may be regarded as natural and correct, but there is a doubt about the accuracy of the interpretation. This variety is met with in those who dwell in the world of scientific inquiry. The doubt relates to the subjective interpretation alone. Some individuals distrust their own and others' memory, and spend the greater part of their time in attempting to verify the accuracy of recall of former conditions and events. This distrust or doubt is seen in every grade, from the individual who knots his handkerchief in anticipation, to the feverish revision of work by the student who is going in for an examination. The various forms of paramnesia may be associated with doubt, and there may be a great difficulty in making a distinction between the memory of a fantasy and a reality. The logician is almost constantly in a world of doubt, and sometimes distrusts his own ratiocinative powers, apart from the question of the validity of the data presented to him.

Among those who possess highly emotional temperaments, the conditions of doubt play the greatest pranks. Some individuals continually engage themselves in the contemplation of their own moral welfare. Conflicting emotions of right and wrong influence them at every turn. The struggle of the attempt to know themselves and to save their souls is pursued with morbid intensity. Of the ordinary doubts which arise in connection with religion we need not speak. The over-conscientious and the scrupulous reproach themselves on every occasion. They live in a world of conscience, and refer every trivial circumstance to its test. Professor Ball states, that such patients bore their hearers from the habit they have of being over-precise in expressing themselves, this over-precision being actuated by the dread of not telling the exact truth. This variety of doubt is seen in every grade from the individual who dwells upon the adjustment of his outer person, to the philosopher who, through fear of misinterpretation, constructs a sentence replete with interpolations or parentheses.

Some individuals think twice before doing a thing. Others think oftener. As a rule, the oftener they think, the greater the hesitancy and doubt. With some the *pros* and *cons* weigh evenly, and the condition remains stationary. The play of motives and the fear of results determine much of the inactivity of the insane. Over-cautiousness deters from action. Anger and maniacal states further action. The doubt as to whether we have performed actions or not is seen in every grade, from the condition of the paramnesic liar, who, through oft telling his tale, at last doubts whether he was the hero or not, to the condition in which we get out of bed to bolt the door, or put out the gas in our studies. Some people perform actions in a normal manner during the day, but reflect upon them during the night, and suffer agonies of mind as to whether they have done the right thing. Such states vary from the dreads of heavy financial speculations, to the doubts of the effects of a tempting piece of pie-crust.

The mind of the medico-psychologist is apt to be influenced and determined this way and that by the conflicting doctrines of the materialists and spiritualists, until disbelief is succeeded by doubt, or doubt by disbelief. There are some individuals who doubt the identity of others until they have closely inspected them and have reassured themselves upon the point. Others possess the feeling that objects are illusory or even hallucinatory, and proceed, by touching or other means, to verify the reality of the object. Those who speculate about the supernatural are apt to superimpose the imaginary upon the real, and thus to create difficulty in distinguishing what is fantasy and what is reality. The ordinary objective conditions, upon the nature of which doubts are entertained, have already been discussed under sensory perversions.

The insanity of doubt is generally regarded as unfavourable as to curability, although it seldom or never ends in dementia. Sometimes remissions occur. Professor Ball believes that those in whom the disease declares itself at the age of puberty have a better chance of recovering than others, the progressive evolution of the organism appearing to exercise some power in ridding them of this psychological disorder.

In the insane the duration of the belief state is generally prolonged through contemplation of the object of belief.

Sometimes the feeling-colour of belief is clearly marked, at other times vague or conflicting. Thus in some cases the feeling of belief is distinctly pleasurable, as in the general paralytic or delusional monomaniac; or, on the other hand, it may be more disagreeable than the state of doubt. The law that repetition of a sequence tends to make it a belief-generator, and that the intensity of the belief bears a relation to the frequency of repetition, holds good with the sane and the insane. The firm and inevitable beliefs of the insane result from the uniformity of the sequence. The feeling-colour of a state of doubt is, according to Newbold, usually disagreeable, but is largely dependent upon the relation existing between the feelings attached to its component beliefs. Thus, the feelings which accompany both belief and doubt may vary from "bliss" to "agony" respectively.

IMAGINATION.

When we imagine a thing, the image which is imagined is in reality composed of factors recalled to memory, either in their former or perverted form. Imagination also implies that the images of memory are combined or modified in some new way. Hence the process has been termed constructive. Thus, the factors of the primary images may be present, but the secondary process of grouping these factors into a new form is essentially derivative. In the sane the factors are to a great extent recognised by the individual in whom they occur; their source is appreciated, and their nature correctly interpreted. In dream states the nature of the factors is not appreciated or recognised at the time, but afterwards; whereas, in the half-way conditions between sanity and insanity the element of primary memory is unrecognised or misinterpreted, and to the new combination a belief in its objective reality is added. In the insane there is not only belief in the actuality of the new combination, but there is, with the fallacy based upon false premises, a tendency to act upon the belief. We all tend to form false combinations in this way. On the one hand, our memories of distant percepts or combinations of such percepts are apt to become hazy, and undergo changes or modifications; whilst, on the other hand, our environmental, our physical and mental disposition at the time of the present construction may furnish the chief determining factors in the new process. This is exemplified in the condition of nightmare, and in the insane. When we read or learn a thing the imagination is nearly always in play: we present a visual image of nearly all our acquisitions. In order to grasp the full meaning of new mental states in others, and the factors which take part in their production, we have to consider (1) the data upon which the new fact is built, and (2) the nature of the new construction, and its import in relation to belief and conduct. This involves (1) the representation to us (by memory of analogous states in ourselves) of the data suggested by the object; and (2) the formation of a new construction, if possible, in harmony with the construction of the individual we study. Upon these factors depend the amount of insight and clearness of conception we form as to the true nature of the imaginary process in others. When we speak of sympathy we shall see how important are these factors.

The constructive process has been described as passive or active. In conditions of memory, where there is revival by suggestion or similarity, an amalgamation is sometimes made by the imagination. In dream-states unusual combinations sometimes take place by suggestion from without (*e.g.*, as in the hypnagogic states already referred to), or the state may be determined by some physical suggestion from the body. In hypnotic states there is, according to some authors, a certain amount of activity displayed, whereby the new combination is built upon suggestions from without. Others deny the presence of such activity, and state that the mind is passive. In the insane (*e.g.*, in acute maniacal states) there is little or no active self-direction of the mind to the construction of new images. According to the more generally accepted theories the process may be regarded as passive. The perceptive power is sometimes so abnormally sensitive, and the suggestions by memory and from without are so rapid and at times so intensified that, within the regions of consciousness, a number of successive images are conjured up almost automatically, without active effort. As an example of active imagination, we may mention the mental physiologist who conjures up scenes of molecules and forces acting upon them, etc., and describes them systematically. It implies an effort of the will which later involves strain. It is, nevertheless, the active constructive process which benefits our minds most. We must recognise that there are limits to the imagination. We can only combine varieties of retentions in new proportions. We see a varied series of such new combinations ranging from fairy tales and scriptural beliefs in the concrete to the fanciful and absurd delusions of the insane. We may acquire knowledge by means of books, and our cognitive imagination may be stimulated from the receptive side or aspect; or the creative side of our cognitive imagination may lead to discovery, and new facts may be revealed in great part by anticipation. The receptive side of the imagination is also brought into play in the process known as imitative construction. Thus, one finds that hallucinations and delusions from the mental side, and movements from the physical side, are propagated from one to the other. This imitative process is well exemplified amongst idiots and imbeciles; in every day life, also, we see the more or less unconscious imitations of actions and modes of thought. By the grouping of the different acquisitions we gain the power of invention. In all imaginative activity there is some accompaniment of feeling or emotion.

The imagination is a function of mind which requires most careful watching. In the "day dreamers" you have an example of the result of excessive indulgence of the imagination. Such an individual is generally purposeless. With too diffuse a consciousness there is apt to evolve an unhealthy conceit, especially in adolescents. On the other hand, there is a danger in not giving sufficient exercise to the imagination. One meets with numbers of persons who have a large retention of acquisitions with but little originality of mind. Too much attention to the concrete is thus often an obstruction to mental development.

There is great variation in the imaginative power possessed by the special senses. Some individuals are deficient in visual imagery. In others, visual imagery is enormously developed, and there is a tendency to illusory phenomena. Binet believes that the auditory type is rarer than the visual, and that persons with auditory hallucinations, or those afflicted with mania with ideas of persecution, may all belong to the auditory type. He also believes that the predominance of a certain kind of imagination may predispose to a certain order of hallucinations and perhaps of delirium.

Fechner has tried to differentiate between after-images and images of imagination as follows:—

After-Images.	*Imagination Images.*
Feel coercive.	Feel subject to our spontaneity.
Seem unsubstantial, vaporous.	Have, as it were, more body.
Are sharp in outline.	Are blurred.
Are bright.	Are darker than even the darkest black of the after-images.
Are almost colourless.	Have lively coloration.
Are continuously enduring.	Incessantly disappear, and have to be renewed by an effort of will; at last even this fails to revive them.
Cannot be voluntarily changed.	Can be changed at will for others.
Are exact copies of originals.	Cannot violate the necessary laws of appearance of their originals —*e.g.*, a man cannot be imagined from in front and behind at once. The imagination must walk round him, so to speak.
Are more easily got with shut than with open eyes.	Are more easily had with open than with shut eyes.
Seem to move when the head or eyes move.	Need not follow movements of head or eyes.
The field within which they appear (with closed eyes) is dark, contracted, flat, close to the eyes, in front, and the images have no perspective.	The field is extensive in three dimensions, and objects can be imagined in it above or behind almost as easily as in front.
The attention seems directed, forwards towards the sense-organ, in observing after-images.	In imagination, the attention feels as if drawn backwards towards the brain.

The Neural Process of Imagination.—Bain believes, that it is only a milder form of the same process which occurs in perception, and that the renewed feeling occupies the very same parts, and in the same manner as the original feeling.

The question as to whether nerve-currents can run backwards requires consideration. Some authors hold that peripheral sense-organs can be excited from above, others say they can only be excited from without. Braid, writing on hypnotism, believes that a nerve-current can be made to flow to the periphery mimicking the influences from without in sensation. The imaginative process must be initiated in the first place by some material condition in the brain itself, or in the structures which subserve the mind. It is held by some that currents do flow backwards down the optic nerve in Meyer's and Féré's negative after-images, and from this it is assumed that in all imagination there is possibly some slight degree of backward flow. If a suggestion is made to a person in an hypnotised state that a sheet of paper has a red cross upon it, and a pretence is made to remove the imaginary cross whilst the subject is told to look fixedly at a dot upon the paper, he will presently tell you that he sees a bluish-green cross. Binet believed the optical brain centres, and not the retina, to be the seat of ordinary negative after-images.

Undoubtedly the negative after-images of Meyer and Féré are difficult to explain, and they appear to be paradoxical to all we know of the direction of nerve-currents. Our knowledge upon this subject, however, is so meagre that we are not in a position to negative or support either view.

Our knowledge of the physical processes which underlie attention, conception, judgment, belief, and imagination is, as yet, of little practical value. We do not know how or where the brain facts come into apposition with the mental facts.

Pathology has taught us that disease of a nerve will sometimes give rise to morbid ingoing stimuli. Morbid conditions of the various sensory centres in the cortex have been demonstrated as producing similar results. Hallucinations are said to be due to disease of cortical centres, and yet we have seen that these very centres which are said to be diseased transmit ordinary sensory stimuli without the slightest indication of illusory accompaniments. When we eliminate the sensory areas we are no better off. We only throw the responsibility for the production of the morbid ideas upon the material substratum which is believed to give rise to ordinary mental states. Here again we meet with the same difficulty. What is the pathological state which will determine the growth and development of morbid ideas, and an insane course of reasoning, and yet leave the patient in every sense a philosopher, and, in some cases, more brilliant intellectually than before? A transcendental pathology would seek the explanation in the arrangement of molecules, and in the unequal distribution of force and the resistance which it overcomes.

Within the minute ramifications of the nerve-fibres of the morbid area there would be at least some molecular activity or disposition which constantly tried to overcome resistance, and in so doing stimulated consciousness in a specific and morbid manner. If we assume that the area affected is a small one, then we must also assume that by its activities alone the judgment of the *ego* is overcome, and since a thorough-going materialistic theory grants nothing to the mind itself, it must explain how the material disposition can affect the totality of the mind at one time, and yet fails to influence it at another.

If the mind is to be located in the cortex as a complex epiphenomenon, having as the basis of its component parts some one specific material substratum, then it is also reasonable to assume that, in order that these component parts may be gathered into one disposition which would be the material unit upon whose functional activity our complex ideas would depend, there must be corresponding material movements which ultimately combine and present the complex result to the mind. We cannot conceive the location of mind in any supreme cell; nor, in fact, can we locate it in any cells or processes. For us such conceptions are idle; we can only view the mind as an epiphenomenon having no community with any structures of which we know the essence. That mind is fixed upon one definite and ultimate substratum we cannot therefore conceive; nor can we conceive that it flits from one region to another as a movable quantity having a physical mode of motion.

The physiological theory of mind must of necessity transcend all we know of matter and force, and this encourages us in the belief that the arguments of the would-be scientific exponents of mental events in terms of physical force are more truly conjectural and speculative than those of the individuals who recognise that they have a mind to think with and a body to serve it.

Morbid Conditions.—As we have already seen, delusional states are often associated with illusions and hallucinations, and the presence of delusions does not necessarily imply a condition of mental weakness. Such patients are often shrewd and intelligent, their memory is good, their volition strong, and they are able to keep their emotions well under control. Delusions may be grouped according to their occurrence in the sane, in half-way conditions between sanity and insanity, and in insanity. In the *sane* we see every variety of delusion, arising in some cases from false sense-impressions or illusory phenomena, in others from the propagation of false intellectual beliefs, as in the various psychopathic epidemics, and as the result of ignorance. In the half-way conditions, delusions arise in the hypnagogic state, and we see every variety between the effects of dreaming and those of nightmare. Among superstitious and hysterical people false beliefs find as suitable a soil for growth as in the imbecile or weak-minded. We are also subject to temporary delusions which are the outcome of emotions or loss of control. An *insane* delusion is defined by Clouston as "a belief in something that would be incredible to sane people of the same class, education, or race, as the person who expresses it, this resulting from diseased working of the brain-convolutions." An insane delusion affects the conduct of life, and is not due to ignorance. It is comparatively rare to find instances of pure monomania, or the presence of one simple delusion only. Clouston has pointed out that the ordinary form of delusional insanity is for the delusions of the patient to refer to one particular subject or set of subjects, or for him to be morbid in a particular direction of intellect or feeling, while he is sound in most directions.

There are two ways of grouping cases of delusional insanity :—

1. *Simple delusional states.*
   (*a*) Gradually developed from birth (idiots, etc.).
   (*b*) Evolved at some other period of life (as in the evolution of conceit in adolescents).

(*c*) Temporary conditions—acute delusional states—due to some physical disease or disorder, or determined by mental stress or strain.

Sensory types.

(*a*) Illusory states, determined by the environment or by the organism.

(*b*) Hallucinatory, due to physical or mental causes.

Emotional or affective types

Determined by some active emotion.

2. Some writers have classified the delusional states from a clinical point of view, as follows :—

(*a*) *General* — total upset of reasoning powers, of temporary duration and general character.

(*b*) *Partial*—sensory types, in which there are illusions and hallucinations.

(*c*) *Monomanias.*

(1) Of unreal greatness, as seen in the conceited in religious imposters, and in the maniaca and chronic forms of insanity.

(2) Of unfounded suspicions, due to sensory disturbances or other causes.

(3) Of unseen agencies, in which there are ideas of persecution by means of electricity, machines, etc., and sometimes having bodily causes of disturbance which are misinterpreted.

(*d*) *States of defective intellect*

Includes the delusions of imbeciles, idiots, the morally insane, liars, and beasts.

Delusions may arise (1) in regard to an individual's self-consciousness. He may become exalted, or depressed, or he may have an alteration of consciousness and believe that he is some one else. (2) They may relate to the individual's physical organism, as the outcome of sensory disturbances. (3) They may relate to any part of the physical or social environment. (4) Not only may a man feel that he has lost himself and is some one else, but there may be an alternating condition, in which he believes he is at one time one individual, and at other times another; or he may believe that he is two persons at once.

In the insane, delusions may precede an attack of excitement, depression, or other form of disorder; or they may arise secondarily to an emotional state of depression or excitement; or as the result of sensory troubles, or as a sequel to an acute attack of mental disorder

From a clinical point of view the causes of delusional states may be grouped as predisposing and exciting. *Predisposing* causes are:—Inheritance, causes acting at birth, previous attacks, excessive emotionalism, periods of life (puberty, adolescence, climacterium, senility), only childhood, sexual excitement, etc. *Exciting* causes are:—Ordinary conditions of shock, stress or strain, bodily disease or weakness, gross lesions of the brain (apoplexy, syphilis, etc.), local diseases of sense-organs, poisons (haschisch, alcohol, etc.). The cerebral pathology of a delusive idea is unknown to us. From a psychological point of view, we can explain how errors arise in many instances, but, when we try to superimpose this explanation upon the facts of cerebral pathology at our command, we find that the task is, as yet, hopeless.

It is held by some, that in patients who are suffering from delusions or compulsory ideas, the regulative influence of the sensations or of the external stimuli upon ideation has either been removed or has lost the persistency of its action. Hence, according to Ziehen, the association of ideas produces judgments that are completely contradictory to the processes of the external world. No doubt this is a view which might, to a certain extent, serve to explain what does occur; but it does not cover those delusional forms of insanity in which the individual's sensory apparatus is working as efficiently, and the intellectual interpretation of the presentations is as correct as in the sanest of the sane. We believe that the association of ideas influences the sensations to a certain extent, and we can understand, in a psychological sense, how the ideational life can be removed from the control of the sentient life, but we cannot form any notion as to the brain-state which separates the ideational from the sentient life and yet allows free play of both intellectual and sensory functions when the mind is engage with the contemplation of states other than the delusive.

CHAPTER XI.

MEMORY.

Elementary Memory—Memory Proper—Secondary Memory—Relation of Memory to Belief—The Process of Recollection—First Impressions—Suggestion—Contiguity, Similarity, and Contrast—Associative Force—Complex, Convergent, Divergent, Obstructive—Methods of Cultivating Memory—Psycho-Physical Theory of Memory—Latent Mental Images—Relation of Primary Image to Revived Image.

DISORDERS OF MEMORY.

Forgetfulness—Amnesic States—Congenital Defects—Temporary Loss—Periodic Amnesia in Hypnotic States—Progressive Amnesia—Partial Amnesia—Agraphia, Aphasia, Aphemia, etc.—Hypermnesic States—Congenital—Temporary—Periodic—Partial—Paramnesic States—Simple States—By Association or Suggestion—By Identification.

MEMORY.

In order that a mental state may survive or be capable of being reproduced in memory it is essential that the primary presentation should have remained in consciousness for a certain length of time. States of mind are, as a rule, of little intellectual value to us unless we are able to retain them in memory and can recall them at will. The term *elementary memory* has been employed to indicate the memory or awareness of the thing just past. *After-images* differ from objects of elementary memory, in that the former are due to the continuance of the process of excitation of the nerve-centres after the removal of the object. As we have already seen, the after-images may be positive or negative. The positive are like percepts, but move with the position of the eye. When we recall to memory an object which has been absent from consciousness, but which now revives, the process is termed "*memory proper*" or "*secondary memory*."

In addition to the revival of a former presentation, of which, meantime, we have not been thinking, memory proper includes the additional consciousness that we have experienced it before —*i.e.*, there is the feeling that the "I" which witnesses the *re*-presentation has also witnessed the presentation. Many writers make the assumption that the revival of an image is all that is needed to constitute the memory of the original recurrence. Several psychologists, however, have shown that no memory is involved in the mere fact of recurrence. In order that the recalled image may stand for the past original, the recalled image must be *referred to the past*, and in so-doing its associates and conditions of occurrence in the past are also referred to. Memory requires even more than this. The fact which occurred in the past must be a fact which occurred in *my* past.

The elements of every act of memory are, therefore, (1) a general feeling of past direction in time; (2) the perception of the date and accompanying conditions of the fact recalled; and (3) the feeling that the presentation and the representation of the object are part of *my* own experience. Exercise of memory presupposes (1) retention of a remembered fact, and (2) reminiscence, recollection, reproduction, or recall of the retained fact.

The relation of belief to memory has received a considerable amount of attention. An object of memory is regarded as an object imagined in the past, and to which the emotion of belief adheres. The consciousness that there is a relationship between the facts we remember and ourselves is supposed to give an object the characteristic quality of reality. A merely imagined past event is, therefore, regarded by some authors as differing from a merely recollected one only in the absence of this peculiar feeling of belief.

Memory has been described as *passive* or *active*. The active form of memory is seen in the process of *recollection* or act of recall. The conditions which determine the efficiency of the act of recall are as follows:—1. *The depth of the first impression:* this depends upon (*a*) the amount of attention paid to it; (*b*) the number of times the impression is revived in the mind; (*c*) the amount of retentive power possessed by the individual.

2. *The force of suggestion:* this depends upon (*a*) the *contiguity* of the presentations or impressions. When objects occur together or in succession they tend to revive together, or they may recall or suggest each other. This is the "law of contiguity." The degree of associative force often determines recall—*e.g.*, the term hospital suggests patients. The train of representations may be symbolic, motor, or verbal. (*b*) The *similarity* of the objects presented. (Spencer reduces contiguity and similarity to the same law.) (*c*) The *contrast* between objects presented. By this is meant that one fact suggests its exact opposite—*i.e.*, there are always two sides to a question. Poverty suggests its opposite wealth. A statement bearing upon some medical question suggests facts which are part of our experience, and which are in direct opposition to the statement made.

3. *The associative force* which may be (*a*) *complex:* one simple object may suggest innumerable associations. (*b*) *Convergent:* several threads of association may tend to further the act of recall—*i.e.*, one series of associations may be imperfect, but the others make up for the deficiency (*e.g.*, in reciting a poem the associations are suggested through the sense of sight, hearing, motor activities of speech-organs, etc.). (*c*) *Divergent:* too many associations sometimes tend to hinder the process of recall in a certain direction. This form has been sometimes termed (*d*) *obstructive:* in acutely maniacal states the tendency to divergence through hyperactivity of associative suggestions often leads to complete inability to recall in a certain direction.*

With improvement in memory it is found that there is increased facility in fixing the primary impression; there is less need for the forcible act of concentration of the attention; impressions are retained longer and more perfectly; they can be more easily revived, and when revived they are in a more perfect form. The growth of memory and its skilful management are dependent upon our power of concentrating our attention upon what is essential. When we think about things, when we group and arrange them in a systematic way, forming diverse and numerous associations about them, we lay

* Sully, "Outlines of Psychology."

the seeds of a good and efficient memory. We all possess a certain amount of physiological retentiveness which it is almost impossible to increase. We can improve it by carefully selecting the material to be stored in it. When we think about a thing we increase its tendency to survive in memory. The more we think the better we remember. All improvement is to be sought in the way we habitually record facts. Kant gives three methods of cultivating memory. These are:—(1) The *mechanical* method, by linking together the symbols in series; (2) the *judicious* method, whereby the logical relations of the ideas are made the connecting link; and (3) the *ingenious* method, whereby symbols or "tips" are employed. Stewart gives as the characteristics of a good memory:—(1) Quick acquisitive skill; (2) retentiveness; and (3) facility in reproduction. Drobisch gives four factors—viz.: Facility, trustworthiness, lastingness, and serviceableness of acquisitions. A person may have a good general memory (Macaulay, Pascal) or it may be good only in special directions—*e.g.*, Mozart, Doré. The characteristic differences lie in the various degrees of perfection of the sense-organs and their discriminative capacity, the amount of interest and attention bestowed upon objects, also, in circumstances, exercise, and education.

PSYCHO-PHYSICAL THEORY OF MEMORY.

Memory is regarded as a mode of consciousness, which is one of the primary elements of the mind; it can be separated from other modes of consciousness and is a correlative of certain changes which take place in the brain. Every act of perception involves an element of memory, so that in the acquisition of new modes of action or thought memory plays an important part. As a rule, actions which are instinctive are little guided by memory. Memory belongs, according to Ross,* to that class of physical states which are in process of being organised.

Ribot says, "It is only when a resistance is offered to the flow of energy from the impressions made on the surface to the muscular excitations necessary to effect the appropriate bodily adjustments, or

* "Brain," 1891, p. 48.

from the presented impressions to the nervous changes which are the co-relatives of the represented impressions, that the psychical state is a conscious one, and can afterwards become a part of memory. When the nervous connections become so fully organised that the resistance to the flow of energy ceases, the psychical states have no appreciable duration, and cannot be regarded as a part of memory. The more complicated the impressions are the more resistance is offered, other things being equal, to the onward flow of energy from the sensory inlets to the motor outlets, and the more are the corresponding psychical states attended by consciousness. Many of these complicated impressions, not being repeated again in experience, fade from the memory; but those of them which are so profound in strength that they are attended by a strong emotional disturbance become permanently stamped upon the organisation, and subsequently recur in the mind as memories. And when one such complex experience calls up other experiences which are also complex, and not frequently repeated, the cohesion between them is feeble; and the transitions, taking an appreciable time, the answering psychical states become part of memory."

In the attempt to explain memory from a psycho-physical point of view much attention has been given to the theory of latent mental images, and to the material processes which are supposed to bring the images of memory into consciousness. With regard to the latent images it is assumed that, with the various impressions, derived in consciousness through the instrumentality of the nervous substance, there is a corresponding deposition of the mental image upon the material substratum, and that this image can be renewed in consciousness by a material process or disposition initiated by suggestion from within or without.

Let us now try to understand the nature of this deposition of latent mental images, and let us endeavour to form a working hypothesis as to the nature of the process of recall or revival in consciousness. Firstly, we are told that impressions, presentations, etc., arise in consciousness when there is some resistance overcome, or some new passage opened out in the complicated branching structures of the cortex. With this mechanical condition there is some corresponding state of feeling which becomes a registered and stored substance, having as its accompaniment the material condition which is capable of reproducing, with some approximation to the original intensity, the quantitative and qualitative phenomena of the impression. The feeling of resistance must of necessity accompany qualitative as well as quantitative conditions. Otherwise we grant to the mind a power of discrimination dependent upon its own laws and not upon those of matter. The so-called latent mental image is thought to be stored somewhere in the cortex, and we imagine possibly in the nerve-cell or its ramified processes. It is customary to speak of and imagine the physiological substratum of, say a sensory impression, as an arrangement of molecules upon which is stamped the equivalent of the latent image. The facts derived from the study of partial aphasias seem to demonstrate that some parts of the cortex are concerned with the registration of images of memory; but we do not, as yet, know what elements in that cortex are intimately concerned with the process.

If we look at the nerve-cell with its complicated branching processes we cannot point to any part of its structure and say, that at that position is the molecular counterpart of a stored image. Nervous tissues are subject to the constant changes brought about by nutrition, metabolism, etc., and it is difficult to understand the permanence of the material counterpart of the mental image in spite of the changes which the tissues undergo. This difficulty, however, is of little importance as an argument against the view that physiological modifications do remain as the physical equivalents of memory images. We all know how a scar may remain through life; and, moreover, just as we may have an acquired motor act, such as swimming, retained through a long period of life, due to the physiological disposition of the motor nerve-cells, so it is conceivable we may have retention of the higher nervous dispositions which have more intimately to do with memory.

Another difficulty, which has been urged by some authors, is to find room for all the memories of a lifetime. Should the student desire to form an estimate as to how many material dispositions he ought to provide storage for, he must first recognise that no one mental impression is the exact counterpart of any other, and that, therefore, each impression must have its own material basis from the beginning to the end. No modification of a former impression, by a new impression superimposed upon it, can interfere with that first impression, which remains as it was in the first instance, and can be reproduced only as such. Every presentation is dependent upon a physiological process, and every representation necessarily depends upon a repetition of the process which at first gave it rise. The problem, therefore, becomes to find room for the material processes upon which the revival of the entire contents of memory would appear to depend. The inability on our part to conceive how the accommodation is affected must not, however, be regarded as giving support to the argument of any metaphysicians who might advocate that the brain is unequal to the task. The connections among the brain-elements are infinite, and if a single germ possesses the organic and latent mental characteristics of the parents, what limits are there to the possibilities among the millions of cells of the brain?

During the course of a day mental images succeed each other so rapidly that the task of estimating their number would be found quite impossible. Some authors maintain that the recall of an image is a re-creation, really a new presentation, not the old image. Baldwin says that we never have the same representation twice. This would lead us to the conclusion that the more we draw from the stores of revivable images, the more we add to the dispositions which are capable of revival. That is to say, when we experience the revival of an image the material disposition upon which the revival depends does not alter in itself, and, inasmuch as no reproduction of the primary image is the exact counterpart of that primary image, each revived image must have an equivalent organic state which remains as the latent mental image of a revived image.

The relation of the primary image to the revived image would appear to be as follows:—(1) The primary image is associated with a physiological impress or disposition which may be regarded as substantially persistent. This would agree in part with Aristotle's doctrine of material residues. The revivability would appear to be due to certain only partly explained laws of psychological and physiological habits. (2) Before the image is revived it entirely disappears from the mind. According to the Herbartian theory, it falls below the threshold of consciousness, but still enters as a factor in the complex whole of consciousness. This, however, is a metaphysical assumption which is not susceptible of proof. It appears more reasonable to assume that the primary image disappears entirely, and is revived only with the activities of the physiological disposition of the primary image. (3) With every revival of an image the conscious accompaniments of the revived image differ from the accompaniments of the primary image; hence it is that the revived image appears to differ from the primary image. (4) That we are able to recall a revived image is explained by the fact that we are able to recall the conscious accompaniments of the revived image—*e.g.*, I see figure A on Monday and recall it on Tuesday. On Wednesday I am able to recall the revived image of Tuesday. The image of Wednesday would, therefore, consist of A + Tuesday's accompaniments. Any change in the nature of the revived A would only be one of degree or intensity: the conscious accompaniments give rise to the appearance of change. Hence it is that—apart from the defects of memory, and the distortion of images due to toxic agents or disease—the revived image *per se* is more or less the counterpart of the primary image. The form of the primary image is not necessarily altered when revived. Such an alteration would be possible only when the actual object that occasioned the image is represented—*i.e.*, a renewal of the actual impression by the presence of the object would be in reality a new presentation.

In the various accounts of the pathology of amnesic defects it is generally assumed that the material dispositions of the images of memory tend to become effaced or rendered inert. Many theories have been advanced to explain how the images of memory gradually lose their intensity. Hitherto, however, the consideration of the laws of association of ideas has been the only method which has served to partially explain some amnesic defects, and this desiderates a psychological rather than a physiological explanation.

Before we can hope to arrive at definite conclusions as to the nature of memory we must determine (1) whether the brain-tracts excited by the events proper and those excited in their recall are the same or in part different from each other; and, first, before we can do this, we must ascertain more as to the nervous structures involved by the events proper; (2) how far memory is conditioned by the number and persistence of the various brain-paths ; (3) what structures in the cortex are more intimately concerned with the registration or storing of the physical equivalents of mental images. When we have obtained more light upon these subjects, then, possibly, we may advance a step and endeavour to offer some explanation of the psychological facts of suggestion, association, and contrast.

DISORDERS OF MEMORY.

Forgetfulness is regarded as an equally-important function with remembering, and in the construction of a good memory the art of forgetting is essential. James says, that "selection is the very keel on which our mental ship is built." Undoubtedly there are many dangers in forming too many paths of recall. Ebbinghaus has tried to establish a numerical relationship between the amounts remembered and those forgotten, and has given the following law : "The quotients of the amounts retained by the amounts forgotten are to each other inversely as the logarithms of the various periods of time that have elapsed."

Just as memory is one of the first of the mental faculties to be developed, so it is one of the first to undergo impairment in old age. The culminating point of mental development is held to be at the period when there is loss of the power to build up new acquisitions. The decline of memory has been divided into different stages. The most recent, and, therefore, the least organised, associations are the first to give way. In mental diseases, just as in disorders which involve loss of memory for words, those kinds of words which are least organised are the first to disappear.

Locke described two main defects in memory—viz., oblivion or want of tenacity and slowness, or want of readiness in reproduction. From a psychological point of view disorders of memory may be classified as conditions of (1) amnesia, loss of memory; (2) hypermnesia, exaltation of memory; (3) paramnesia, illusions of memory. Of these classes the various forms of amnesia are the most important. The following is perhaps the most convenient method of classification.*

* Ribot, "Diseases of Memory."

Amnesic States:—

1. *Congenital* defects.
2. Conditions of *temporary* loss.
   (*a*) In epilepsy, etc.
   (*b*) Following injury or shock.
   (*c*) In acute mental disorders.
3. Conditions of *periodic* loss.
   (*a*) In states of double consciousness.
   (*b*) In somnambulistic states.
4. Conditions of *progressive* loss.
   (*a*) In general paralysis of the insane.
   (*b*) Associated with various brain lesions.
   (*c*) In senile dementia.
5. Conditions of *partial* loss.
   (As seen in loss of memory for numbers, music, sounds, names, agraphia, aphasia, aphemia, word-blindness, and word-deafness, etc.)

Hypermnesic States:—

1. Congenital.
2. Temporary.
3. Periodic.
4. Partial.

Paramnesic States:—

1. Simple states.
2. By association or suggestion.
3. By identification.

Amnesic States.—*Congenital* defects of memory are met with in idiots, imbeciles, and cretins. The memory may be deficient generally, and the individual fails to register impressions; hence there is failure in intellectual development. Ribot is inclined to the belief that a careful study of the mental symptoms in idiots would enable us to determine the anatomical and physiological conditions of memory. He states that memory is dependent upon the constitution of the brain, and that in idiots and imbeciles the condition is abnormal. As a general rule the memory in idiots and imbeciles is unequally developed, and it is not uncommon to meet with partial developments in a special direction associated with absence of memory in other directions.

Temporary loss of memory is found in every grade, in both the sane and the insane. The amnesic state may last only for a few minutes, or it may remain for several years. In epileptic states the most characteristic instances are to be found. Ribot regards the three forms of epilepsy—viz., *grand mal*, *petit mal*, and epileptic vertigo, as different degrees of the same morbid state; and he points out that the more moderate the attack in external manifestations the more fatal it is to the mind. Such states have been designated as *mental automatism* (Hughlings-Jackson).*

Two hypotheses have been advanced to account for the period of mental automatism—viz.: (1) The period is not accompanied by consciousness, so that nothing can be reproduced; † or (2) consciousness does exist, but in so weak a form that amnesia ensues.‡ The latter view finds most favour with psychologists. Certain cases of mental automatism are very closely allied to dream-states, in which a person may answer questions rationally, having, however, little or no after-consciousness of the events. The explanation of the loss of memory for dreams has been thought to rest in the fact that the states of consciousness during dreams are extremely weak. Magnan § has recorded the case of an epileptic who was alcoholic. The patient, when seized during the day with an epileptic attack, broke everything within his reach, and was very violent. At night time he had alcoholic delirium, with the characteristic terrifying visions. The following day, on coming to himself, he remembered the delirium of the night, but had no recollection of the delirium of the day. Falret has pointed out, as a very important characteristic of epileptic mania, that the mental condition is surprisingly uniform in the different attacks. To the well-known views of Hughlings-Jackson—that mental automatism results from over-action of low nervous centres, because the highest or controlling centres have been put out of use—we shall have occasion to return, so we now

* "West Riding Asylum Reports," vol. v. p. 116, *et seq.*

† Morel, "Traité des Maladies Mentales," p. 695.

‡ Ribot, "Diseases of Memory," p. 73.

§ "Clinique de Sainte-Anne," March 3, 1879.

pass to those forms of temporary amnesia which follow upon an injury or shock.

After an injury or shock the amnesia may begin immediately, and continue for a longer or shorter period ; or it may extend backwards, and include recent or remote events. According to Ribot, it more commonly extends both backwards and forwards. There may be, or there may not be, recovery from the loss. Sometimes re-education is required. It is assumed that either the registration of anterior states is interfered with or effaced ; or, if persisting, their power of revivification by association with the present is destroyed.

Numerous instances are recorded in which, through injury or shock, the immediate antecedent events have been entirely effaced from memory. A blow on the head, a fall, a fever, or an acute illness may produce like effects.

There is a considerable amount of difference of opinion as to the states of memory in acute mental disorders. Clouston advises us to be careful in predicting in states of mental exaltation. He believes that the memory of events, during the disease, is regulated by the degree in which the power of attention is unaffected. Unfortunately, however, it is often difficult to apply the principle practically. Some patients appear to take little or no notice of their surroundings, or of the ordinary occurrences which take place around them ; but on recovery they will often tell you that they noticed everything, and, moreover, their memory may be exceedingly good. More commonly, however, they are apt to distort and exaggerate what has happened to them during their illness. Savage believes that memory begins to fail naturally, in certain particulars, at about middle age ; and that memory of names, of persons and places, and the like, fails in most busy men soon after forty years of age. This he regards as physiological, and as due to two causes—viz. : (1) The middle-aged man has found the futility of collecting matter not likely to be required later ; he has not the same special interest, and does not pay the same attention to new names and faces that he did when a younger man ; (2) there is a limit to the storing capacity of the human brain for disjointed, disconnected facts. Frequently the question arises as to whether a person ought to be detained in an asylum simply on account of defective memory. Savage believes that this is often the kindest and best treatment, especially with old people, who are likely to require constant attention and control. Similarly, a person who has no recollection, but has, nevertheless, desires and appetites, is a person pretty sure (especially if a woman) to get seriously compromised, and, if she have money, to be injuriously influenced, when under no care whatever. In cases of stupor, a distinction has been made between the *anergic* and the *melancholic*, in that the former is attended with loss of memory, due to absence of consciousness; whereas, the latter variety is said usually to imply a memory little affected. This distinction, however, is not always satisfactory, and numerous instances occur in which the memory is unimpaired, even in what have been described as typical forms of anergic stupor.* Bevan Lewis has described the amnesic form of alcoholic insanity, in which there has, or has not, been delusional perversion. He regards the amnesia as the earliest evidence of structural change, and believes that absolute recoverability is rarely (if ever) obtained in this stage of alcoholism. This, however, is not quite our experience; from which we have been led to conclude that the incurability of the amnesic form of alcoholism is not always to be assumed. But if some do not recover, we have, on the other hand, seen alcoholics regain their memory in a most remarkable manner, and leave Bethlem Hospital with little or no trace of their former inability to register or recall impressions.

Bevan Lewis states that the revivability of a former impression, as a resultant, depends upon (1) the intensity of the previous impression; (2) the vigour of circulation and nervous energy; (3) the organisation of such impressions in the establishment of associated sense-impressions; (4) the vigour of the faculty of attention; (5) the element of time. He says:—

"The intensity of the previous impression appears to be of minor importance, but the vigour of circulation, and of nervous energy, is decidedly at fault. . . The conduction along the nervous circuit is impeded in such cases, as proved by the retarded response made to sensory stimuli, *visual* and *auditory;* and this we have more reason to

* Newington, "Journ. Ment. Science," Oct., 1874.

attribute to delay in the *sensory arc* than in the *motor arc*, or it may be due to delay in the transference from the one to the other. Such sluggish transmission can only be regarded as *resistance* in the nervous arc, and as resulting in a diminution of the effective force of the original impact at the periphery. Hence it is that the organisation of such impressions by the establishment of associative links—*i.e.*, *the forcing of new nervous tracts* into adjacent areas—becomes greatly impeded, since this greatly depends upon the vigour of the nervous current and the vascular supply of the part. . . . . Such organisation is greatly aided by the *faculty of attention*, which, when directed towards the impression we tend to revive, fosters the growth of that associative process whereon a persistent and efficient memory is based. Thus it is that slight distraction of the mind, even momentarily, by directing the attention to any other line of thought, will abolish the feeble tendency to organisation of the original impressions which might otherwise occur."*

In all explanations of this kind, one can well understand the employment of such expressions as "resistance in the nervous arc," "forcing of new nervous tracts," etc.; but it must be remembered that such expressions are merely symbolical of hypothetical physiological accompaniments of mental events.

According to Ribot, this form of temporary amnesia is characterised psychologically by the fact, that it appears only in the less automatic and less organised phases of memory. He believes that in cases belonging to this morbid group, neither habits, nor aptitude for mechanical work, such as that of sewing or embroidery, nor the faculty of reading, writing, or speaking a native or foreign language, are in the least affected; in a word, memory, in its organised and semi-organised form, remains intact. It is commonly assumed that temporary amnesia affects only the most highly developed and recent unstable mental attainments. This, however, is not invariably the case. Thus, for example, I have known an individual whose memory for recent events was comparatively good; he nevertheless was unable to recall his own name. We are all familiar with such an experience, and can no doubt narrate instances in which, owing to some slight emotional cause, such as shock, or nervousness, the memory for highly organised events has disappeared temporarily. The physiological explanation of this psychical fact is as yet unsatisfactory. The temporary loss of the most recent acquirements is thought to be due to

* "Text-Book of Mental Diseases," p. 310.

loss of the faculty of registering the latest impressions. This, however, affords no explanation as to the obliteration of what may be regarded as long assimilated and stable acquisitions.

In some instances of extreme rapidity of re-education, it has been thought possible that the memory returns because the atrophied nervous elements are supplanted by other elements having the same properties, primitive and acquired, as those which they replace. This may possibly account for the re-education, but it cannot account for the rapidity of the process. We can readily conceive that new elements may take on the functions of old; but the re-education often means the recollection of impressions which have been conserved and reproduced. This, if the case, would involve restitution of the former acquisitions, revival of the old physiological dispositions, and not necessarily the opening out of new tracts to displace the old.

Periodic loss of memory is a subject which has provided us with occurrences of extreme interest and importance. Under this heading may be included the phenomenon of "double consciousness." In such conditions an individual may have a perfect dual existence, so far as the continuity of conscious events is concerned. The instances of alternation of two personalities may for convenience be divided into two main groups according as the alternation is complete or incomplete.

In *complete* alternation the personality of the individual is entirely different in the two states; there is no continuity of thought, and the memory of one state is absent during the occurrence of the other. A female patient admitted to Bethlem four years ago had such complete alternation that for a period of twenty-four hours she was depressed, thought she was being burnt, and failed to recognise people around her. Then during the next twenty-four hours she was natural and bright mentally, recognised those around her, but had no memory of her experiences on the previous day. Another patient (a male) for several weeks had alternating conditions. One day he would say, "Now then, my lads! bustle up and get me a good breakfast, feel as if I hadn't had food for a week." When asked if he had ever been miserable, he would say, "Never known a moment's unhappiness in my life"; and when questioned as to his present state of mind, he invariably replied, "I'm as fit as a fiddle, hearty as a buck, and as jolly as a sand-boy." During the period of happiness he would laugh, converse with everybody, and eat ravenously. The next day, however, a change would come over him: he would lie in bed, moaning incessantly, grumble at everyone, refuse food, and say that he had never had a happy moment in his life, and always suffered the "tortures of the eternally damned." In this case the alternation could not be said to have been complete, inasmuch as he, in both conditions, recognised and called by name the attendants who looked after him. His memory of the two states, however, was always disconnected. Azam considers that in *dreaming*, the mind, deprived of the co-ordination of ideas and the action of the senses, represents a personality different from the same in the waking state; a personality which is often considerable though incomplete. Similarly, he believes that the drunkard has two lives; his ordinary state and the state of drunkenness, during which latter he may act with an appearance of reason.

An intellectual and highly cultivated lady was recently admitted to Bethlem suffering from melancholia with anergia. Her father was alcoholic; otherwise, her family history was good. Three years previous to her admission she became somnambulistic. She used to make a great noise during the night by banging at her door, shifting furniture, etc. At times she would bump her head on the floor, but never really to hurt herself. During her somnambulistic state she would answer questions intelligently and to the point. When comparatively free from somnambulism she suffered in other ways —*e.g.*, from indigestion and symptoms of gastric ulcer. Under treatment by hypnotic suggestion she improved somewhat; but subsequently relapsed into her somnambulistic habits. Two years from the onset of her first symptoms she began to write letters during the night. These letters were badly written, and only faintly resembled her ordinary handwriting. Subsequently she would do and say things during the day time, of which she had no recollection when in her normal state. Again hypnotic suggestion was tried; but it was found that after the experiment she could not be roused for a period of nearly six hours. When in her normal state of wakefulness she failed to recall any of the events of her somnambulistic state. During the latter state, on the other hand, she could give a connected account of her waking state. Subsequently she developed a third state, somewhat resembling *petit mal*, during which she would steal and hide things which did not belong to her.

Azam has advanced the hypothesis that dual consciousness is only complete somnambulism, or ambulatory automatism. He believes that the successive awakening of the faculties and of the senses constitutes a gradation from ordinary sleep to complete somnambulism, which gives to the person studied the appearance of leading a dual life. "We may meet persons who have the appearance of being like everyone else and who yet, being in the second condition, are only somnambulists, who on awakening will have forgotten everything." Many of these questions are clearly outside our subject, so that we are unable to discuss them here. The medico-legal aspects of this question, however, are of such importance that we cannot do better than quote the words of Azam, who says:—

"We do not hide from ourselves the disturbing questions which this possibility justly raises, especially from the point of view of responsibility. But it is not the business of science to inquire into the consequences of what it affirms. Its duty is at the same time a grander and a more narrow one. It is to establish the *truth*, basing itself on certain well-established facts. Let us carry ourselves back to the times when they burnt hysterical women as witches, because, being anæsthetic under the lash, they were, it was said, in league with the Devil.

"To-day we shrug our shoulders. Will our descendants not shrug theirs in their turn at a period when, considering the inevitable law of progress, our successors will be able to give explanations which we cannot do at the present day, and when that which astonishes us now will astonish nobody?

"Let us content ourselves with registering the facts, after having carefully observed them; others will draw conclusions from them better than we can.

"Then, perhaps, magistrates and physicians will keep pace with the progress of science; they will be better acquainted with the singular states that may render criminals irresponsible, and they will foil the trickery of those who, knowing that these states exist, will simulate them to procure a verdict of 'Not guilty,' as also the exaggerations of the lawyers, who will make the most of them for their purpose. Then, perhaps, there will be compiled for all physicians a forensic medicine in keeping with the progress of physiology and psychology. At present this does not exist." *

* Azam, "Tuke's Dictionary," p. 406.

In connection with the evolution of two separate personalities in the same individual the very important question arises, What is the mechanism which permits of the evolution of two distinct series of associations, which in themselves are complete, but which have no community with each other? We are quite unable to answer this; we can only make vague suggestions as to alternate actions of the two hemispheres, or venture upon hypotheses which, in the present state of our knowledge, it would be impossible to verify.

Memory in Relationship to Hypnotic States.—According to Professor Beaunis, of Nancy, the following laws regulate the hypnotic memory:—(1) The memory of states of consciousness (sensations, acts, thoughts, etc.) of the hypnotic sleep is abolished on wakening; but this memory can be revived by suggestion, either temporarily or permanently. (2) The memory of states of consciousness of the hypnotic sleep reappears when hypnosis is again induced; but this memory can be abolished by suggestion, either temporarily or permanently. (3) The memory of states of consciousness, of the waking state and of natural sleep, persists during the hypnotic sleep; but this memory can be abolished by suggestion either temporarily or permanently.

These laws refer to cases of deep hypnosis only. Memory in relationship to hypnotic states varies widely in accordance with the depth of the hypnosis and the varying personality of the subject operated on. In slight hypnosis there is apparently little or no alteration in memory; the subject remembers during hypnosis the events of waking life, and on passing into the normal condition easily recalls all that has happened during hypnosis. In somewhat deeper stages, on awakening the memory of what has taken place during these stages is less distinct. The subject will then frequently state that he can recall all that has been said to him and that he heard everything. On questioning him, however, it will generally be found that he remembers very little, and that what he has been able to recall fades rapidly.

In the deepest stages the subjects can recall nothing on awakening, and to this condition the term somnambulism is usually applied. The proportion of hypnotised persons who pass into this condition may be roughly stated as about 20 per cent. When a hypnotised subject is unable to recall on wakening anything that has passed during the hypnotic condition the lost memory is very rarely revived spontaneously. A few instances of this are recorded, however, both in the normal waking state and in dreams during natural sleep. This amnesia after hypnosis is sometimes reached in slight hypnotic conditions, when alterations in the voluntary muscles can alone be induced; in other instances it is absent in the deeper stages, characterised by alterations in the special senses. One subject, for example, may be unable to recall on awakening that the muscles of his arm had been rendered stiff during hypnosis, while another may remember distinctly a sensory hallucination or recall perfectly all the steps of a painless operation.

The hypnotic memory is frequently more precise than the ordinary memory, but this improvement is manifested, as a rule, only by those subjects who have forgotten on awakening all that has passed during the hypnotic state. Many instances are recorded of marked improvement of memory during hypnosis. Bramwell has found, for example, that subjects who are unable to recall in their normal condition events in their lives which have taken place at an earlier age than seven years were able during hypnosis to vividly recall what had taken place at the age of three. One young girl, imperfectly educated, who could play a few dance tunes upon the piano, but who could only do so in the normal condition when she had her music before her, was able, when hypnotised and blindfolded, to play the same tunes much more brilliantly. Another patient, whose natural memory was unusually bad, and who could only learn a piece of poetry, for example, with much difficulty, was able to recall on awakening, after suggestion to that effect, some verses with which she was previously unacquainted, and which were only read over to her twice in the hypnotic condition.

Professor Beaunis draws attention to the fact that certain subjects respond to suggestions when in a condition which in many respects resembles the normal waking state. In reference to them he says:—

"One can determine with certain subjects a particular state which is neither hypnotic sleep nor the waking state. The subject is perfectly awake; he has his eyes open, and is *en rapport* with the outer world.

He recalls perfectly all that is said or done around him, all that he has said or done himself, the memory is only lost upon one particular point in reference, namely, to the suggestion which he has just fulfilled; it is by that and by obedience to suggestions that this state resembles somnambulism. These two characteristics are the only ones which distinguish it from the ordinary waking state. I have given the name '*veille somnambulique*' to this condition."

Bramwell has frequently observed the condition described by Professor Beaunis, but has found that it could only be induced in subjects who had been deeply hypnotised on some previous occasion. With some of these, without any attempt to reinduce hypnosis, he could induce alterations in the voluntary muscles or special senses by a verbal suggestion given quietly in his ordinary tone of voice. Sometimes he has found that these suggestions were forgotten immediately they were fulfilled, but in many other instances the subjects recalled them perfectly even after a lengthened interval.

Suggestion plays an important part in hypnotic memory, and it is difficult to be absolutely certain whether any of these alterations just referred to arise quite spontaneously, without suggestion from the operator, or auto-suggestion on the part of the subject. With some subjects the first hypnosis is followed by complete forgetfulness of what has taken place during that condition, even when the operator has carefully avoided all suggestions in reference to the memory, but in such instances one can never be absolutely certain that the subject has not made auto-suggestions as the result of his preconceived ideas in reference to the hypnotic state.

The recollection during the hypnotic state of what has occurred in waking life and in previous hypnotic conditions rarely occurs spontaneously; in the first instance, at all events. In some cases frequent suggestions are necessary in order to obtain this revival of memory, but once induced it will often occur spontaneously in subsequent hypnoses, or, at all events, it will then be capable of easy production by suggestion.

The amnesia, partial or complete, which frequently follows the termination of the hypnotic state can easily be prevented by suggestion. If it be suggested to a hypnotised subject that he shall be able to recall on wakening not only what is passing in his present hypnotised condition, but also all that will take place during subsequent hypnoses, it will be found that the occurrence of this amnesia has been entirely prevented, and that it will not again manifest itself unless suggestions are made with the object of creating it anew.

According to Bramwell, memory in hypnosis may be:—(1) Unchanged; (2) the subject may remember during hypnosis the events of waking life, with a clearness corresponding to his powers of memory in the normal state, and on awakening have a more or less indistinct recollection of what has passed during hypnosis; (3) he may recall during hypnosis the events of waking life to a greater extent than he could do in the normal condition, and, on awakening, may have lost all recollection of what has taken place during hypnosis; (4) he may be unable, owing to suggestion, to recall during hypnosis the events of waking life or those of previous hypnoses, and, on awakening, may have lost all recollection of what has taken place during hypnosis; (5) he may recall during hypnosis the events of previous hypnoses and those of waking life, the latter to a greater extent than he could do in the normal condition, and by suggestion this memory may be retained on awakening.

In this latter condition amnesia has been prevented by suggestion, and there is now no break in the memory of the hypnotised subject. The only alteration is one of improvement; the subject now remembers in the waking state past events which he was unable voluntarily to recall in that condition, but the memory of which he has been able to revive in hypnosis. He also recalls in the waking state the recent impressions he has received during hypnosis — impressions which he would not have been able to recall so vividly had they been made in the waking state. He remembers, for instance, in the waking state, the piece of poetry which has been read to him twice during hypnosis, and which he would have required to have read many times in the normal state in order to retain an equally clear recollection of it.

It has been attempted during hypnosis to revive the memory of what has occurred during the administration of an anæsthetic, such as ether or nitrous oxide gas, but in the few experiments of this kind with which Bramwell was personally acquainted the attempt proved a failure. The same non-success attended his attempts to revive the recollection of what had taken place during normal sleep. With one subject, whose memory during hypnosis of the events of waking life was exceptionally good, he carried out the following experiment:—The patient was in the habit of falling asleep every Sunday afternoon in his arm-chair, and it was arranged that on these occasions he should be read to aloud, and that the same sentences should be repeated again and again. Bramwell afterwards hypnotised him, and tried to make him recall by suggestion what had been read to him. The experiment, though frequently repeated, was invariably unsuccessful.*

We now come to what is perhaps the most important of the amnesic conditions—namely, the conditions of *progressive loss.* Ribot has postulated, that the progressive destruction of memory follows a certain order. His **Law of Regression** is, that *the loss advances progressively from the unstable to the stable.* In cases of general dissolution of the memory, an invariable path is followed—viz., memory of recent events goes first, then that of ideas in general, next feelings, and lastly acts. In instances of partial dissolution the loss also follows an invariable path—viz., proper names, common nouns, adjectives and verbs, interjections, gestures. It is now generally held, that in brain-degenerations the nervous elements are no longer able to store new impressions, nor is it possible to form new dynamical associations. Ribot believes, that the modifications established for years in the nervous elements until they have become organic ("dynamical associations and groups of associations called into activity hundreds and thousands of times") remain; and that they have a great power of resisting destructive agencies. The exactitude of the law of regression is held to be verified in those rare cases where progressive dissolution of the memory is followed by recovery, because recollections return in an inverse order to that in which they disappear. That

* For this account of memory, in its relationship to hypnotic states, the author is indebted to the teaching of Dr. J. Milne Bramwell, who has not only demonstrated the accuracy of his statements, but has also sanctioned the performance of control experiments upon his patients.

the old groups of associations are organised by being called into activity "hundreds and thousands of times" we can imagine, but we do not understand how the law of regression is to provide us with an explanation of the extraordinary revivification of certain recollections when the mind turns backwards to conditions of existence that had apparently disappeared for ever. In such instances, the main conditions of the process of organisation (by repetition) are wanting.

Ribot describes the anatomical cause of this intellectual dissolution as "an atrophy which, first invading the exterior cerebral layers, penetrates to the white substance, causing a fatty and atheromatous degeneration of the cells, tubes, and capillaries of the nervous tissue." He quotes a physiologist who says, organic life is analogous to what occurs in a great commercial crisis: "The old houses resist the storm; the new houses, less solid, go down on every side." Such an analogy would appear to hold good in a psychical sense; but, as yet, we are far from possessing any proof that one layer of the cortex more than another is concerned with the recent or remote acquisitions. We agree with Hughlings-Jackson, who was the first to demonstrate that the higher functions disappear before those which are general and automatic; but we cannot, as yet, go so far as to locate the structures concerned with these grades of function within definite layers of the cortex.

Before leaving this part of the subject, it may be well to reconsider some of the conditions on which conservation and reproduction depend; and this involves some account of the relation between the anatomical seat of the primitive impressions and the nervous elements which are active when the impressions are revived. Ribot says:—

"Primitive acquisitions—those that date from infancy—are the most simple; they include the formation of secondary automatic movements in the education of the senses. They depend principally upon the medulla and the lower centres of the brain; and we know that at this period of life the exterior cerebral layers are imperfectly developed. Apart from their simplicity there is every reason why these first acquisitions should be stable. In the first place, the impressions are received in virgin elements. Nutrition is very active; but incessant molecular repair serves only to fix the registered perception; the new molecules taking the exact places occupied by the old, the acquired state finally becomes organic. Moreover, the dynamic associations formed between the different elements attain after a time to a condition of complete fusion, thanks to continual repetition. It is inevitable, then, that the earlier acquisitions should be better conserved and more easily reproduced than any others, and that they should constitute the most lasting form of memory.

"While the adult organism is in a healthy state, new impressions and associations, although of a much more complex order than those of infancy, have still great chances of stability. The causes just enumerated are always in action, although with modified energy. But if, through the effects of old age or disease, the conditions change; if the vital processes, particularly nutrition, begin to fail; if waste is in excess of repair, then the impressions become unstable and the associations weak."

How incessant molecular repair serves to fix the registered impression is a speculation which we do not attempt to make. Nor do we venture upon any hypothesis as to the physiological counterparts of the primitive acquisitions and the sum total of their revivals. We know that, in a psychical sense, first impressions can be localised in the past; but we also know that revived impressions can be referred to in the past. Further, a first impression, and its series of revivals, can be referred to, and localised in time, as distinct psychical facts. This, we hold, would necessitate an additional modification or rearrangement of molecules, which would admit of the facts being reviewed and compared as distinct and separate events. How we are to explain this registration of every revival, as well as the primitive impression, we do not know. We have yet to invent some chronometrical system of registration, whereby the brain-tracts, excited by the events proper, have it within their power to retain, not only the effects of the first excitation, but also every subsequent re-excitation. To say that the first impression becomes organised by repetition conveys no real physiological meaning. If we assume that the structural elements become slightly modified with every revival, we have to explain how it is that the first impression as well as the modified revivals can still be referrred to.

Maudsley* says:—

"When an idea which we have once had is excited again there is a reproduction of the same nervous current, with the conscious addition

* "Physiology of Mind," 1876, p. 513.

that it is a reproduction: it is the same idea *plus* the consciousness that it is the same. The question then suggests itself, What is the physical condition of this consciousness? What is the modification of the anatomical substrata of fibres and cells, or of their physiological activity, which is the occasion of this *plus* element in the reproduced idea? It may be supposed that the first activity did leave behind it, when it subsided, some after-effect, some modification of the nerve-element, whereby the nerve-circuit was disposed to fall again readily into the same action: such disposition appearing in consciousness as recognition or memory. Memory is, in fact, the conscious phase of this physiological disposition when it becomes active or discharges its functions on the recurrence of the particular mental experience. To assist our conception of what may happen, let us suppose the individual nerve-elements to be endowed with their own consciousness, and let us assume them to be, as I have supposed, modified in a certain way by the first experience; it is hard to conceive that when they fall into the same action on another occasion they should not recognise or remember it; for the second action is a reproduction of the first, with the addition of what it contains from the after-effects of the first. As we have assumed the process to be conscious, this reproduction with its addition would be a memory or remembrance."

Professor James has pointed out that there is no conceivable ground for supposing that with the mere re-excitation there should arise the "conscious addition" that it is a re-excitation. "The two excitations are simply two excitations, their consciousnesses are two consciousnesses—they have nothing to do with each other. And a vague 'modification' supposed to be left behind by the first excitation, helps us not a whit, for, according to all analogy, such a modification can only result in making the next excitation more smooth and rapid. This might make it less *conscious* perhaps, but could not endow it with any reference to the past. The gutter is worn deeper by each successive shower, but not for that reason brought into contact with previous showers."

The hypothesis, that the brain-tracts excited by the event proper and those excited in its recall are in part different from each other, is maintained by some observers to be more conceivable than any other hypothesis. This conclusion, however, requires some explanation. We have already assumed that the difference between a revived image and a primary image (psychologically considered) is one mainly of degree or intensity. The appearance of change in the nature of the revived image being due to the addition of conscious accompaniments, and to the mental complexion of the individual at the time of the revival. This theory involves the supposition that the revived image *per se* is in immediate relation with the physiological factors which were concerned with the registration of the primary image. Further, it seems reasonable to assume that the *conscious accompaniments of the revived image occupy new tracts*, which in some inexplicable way become associated with, and hold in their midst, as it were, the physiological counterpart of the revived image. Thus it is, that the organisation of the event proper would appear to depend upon the number of times it is revived, and, therefore, upon the number of its conscious accompaniments.

It is difficult to imagine that with every revival of an image there is any actual modification of the physiological disposition of the primary image. All change depends upon the addition of new associations which would appear to have their separate and distinct functional provinces. Thus, when we endeavour to recall an incident of long ago, we frequently go back step by step recalling the accompaniments of the revived images until we are able to localise in the past the occurrence of the initial impression itself. It follows as a consequence from this, that facility in the act of recall depends in great part, not only upon the depth of the first impression, but also upon the nature and number of the various accompaniments of the revivals.

One point to be learned from these contentions is, that although the revival of an impression may depend upon the re-excitation of a formerly acquired physiological disposition, the re-excitation does not necessarily modify the primary disposition, which remains as it was. We are now, therefore, in a position to say, that when we speak of organising primitive impressions by the process of revival we simply mean, that the facility for revival is rendered more perfect by means of the additional physiological dispositions which have been associated with each revival. Thus it is, that although the revived image is in a manner born from the initial disposition, in speaking of this process of revival as a process of organisation, we really mean no more than we should do were we to characterise every birth, or revival in the image of man, as another step in the organisation of Adam.

The inability to explain the physiological mechanism of memory does not, however, negative the law of regression from a purely psychological point of view. Clinically, it is important to note that the progressive loss of memory is usually pathognomonic of cerebral degeneration. In the early stages of *general paralysis*, the impairment of memory is sometimes the most marked symptom. Mickle has pointed out, that in some cases of general paralysis the impairment of memory undergoes a remission. When the remission is very marked, he believes that the impairment of memory previously existing has usually been factitious rather than real, and due more to a confusion of thought than to actual amnesia. Nevertheless, we are able to confirm his opinion that the amnesia may undergo a considerable and real remission independently of any other conditions. A general paralytic (a Frenchman) came to Bethlem recently, and it was found that, although formerly he could converse fluently in English, with the onset of the paralysis he could not recall any words or formulate a sentence in English. He was, however, able to understand what was said to him in English.

With various *brain lesions* there is progressive loss of memory. Thus, in syphilitic diseases of the brain and the meninges, intracranial tumours, circumscribed lesions due to foci of softening, hæmorrhage, embolism, or thrombosis; in chronic degeneration of the brain, due to idiopathic morbid processes, traumatisms, toxic agents, etc., the symptoms of progressive loss of memory are often marked. Sometimes the loss follows upon spinal affections, such as locomotor ataxy or multiple sclerosis; or it may result from epilepsy, hysteria, somnambulism, chorea, paralysis agitans, asthma, exophthalmic goitre, or myxœdema. It may be determined at any period of life: thus, it is sometimes seen at puberty, adolescence, climacterium, or in old age. Various local visceral disorders determine forms of insanity in which the memory undergoes progressive degeneration; and lastly, acute fevers, such as smallpox, typhoid, cholera, influenza, etc.; or chronic diseases, such as rheumatism, gout, syphilis, cancer, pellagra, tuberculosis, or malaria, may be attended with loss of memory as a complication or sequel.

In senile amnesia, according to Bevan Lewis, the latest impressions reaching the sensorium may be so imperfectly registered as to be rapidly obliterated, or they may fail to establish the organic connections whereby they become more permanent constituents of the nervous mechanism. He says: "In the nexus of processes connected with, and extending around, a nerve-cell, we decipher the integration of structure upon which its permanence as a functional unit depends, and the more free such channels of communication become, the more fully organised is the structure, and the more stable and resistant to the encroachments of senile dissolutions. The latest requirements, however, are expressed in the structural modifications of the highest nervous arrangements where integration of structure is least advanced, and, unlike those associations which have been called into activity over and over again, many thousand times, they fail in that nexus of communications necessary to their stability."

There will always be great difficulty in understanding how a nexus of processes becomes organised, also how this organisation renders it more stable and resistant to the encroachments of senile dissolution. At present we are unable to fix the latest acquirements upon definite nervous arrangements where integration of structure is least advanced. If new routes are opened out, and new nervous associations formed with the registration of every mental event, then we can readily imagine that in the senile cases there is merely failure in the establishment of new nexuses. Clinically, we have to note that senile subjects fail to register the most ordinary events occurring in their immediate presence.

Andriezen has shown that, *pari passu* with the growth and perfection of movement, there is a parallel growth of protoplasmic processes and collaterals of the nerve-cells in the Rolandic cortex; and he has urged that the same qualitative elaboration of the structure of the special sense-areas is the organic basis for the facts of psycho-genesis. "Quality (*i.e.*, extent and complexity) of cerebral organisation is the real basis of intellectual capacity, and thus a brain small in size (like that of Gambetta) may, from its high intrinsic elaboration, be able to subserve more varied, extensive, and multiform activities in life and thought than others of greater size but grosser organisation can."* It is difficult to understand how the quantitative elaboration of physical structures determines the quality of the intellect. A man who looks at a Punch and Judy show possesses at the time an amount of psychical activity, which quantitatively might compare favourably with that of an astronomer when he beholds a comet. Moreover, an illiterate gossamer may retain the memory of concrete facts (by his method of elaborating associations) far better than a philosopher who deals entirely with abstract thought and its elaborations. Therefore, if memory is to be determined quantitatively in this way, we raise difficulties which are insurmountable. *We cannot reconcile the qualitative phenomena of mind with the quantitative phenomena of matter.* Were the intellectual capacity dependent upon the number of ramifications, and these in turn dependent upon the number of psychical activities, of which they are regarded as the physical counterpart, then it would be reasonable to assume that intellect is merely a quantitative phenomenon. Otherwise, we must raise an hypothesis that ordinary perceptions and associative ideas do not rest upon such greatly elaborated physical processes as do those mental acts which are classed as scientific or philosophical. That is to say, if we wish the physical explanation to be complete, we must give a clear proof that thoughts of a logical, scientific, or philosophical order have more ramifications than thoughts of an ordinary psychological nature.

In a psychical sense, the brain of the illiterate person is as active as that of the philosopher. It is not a question of quantity. We are unable to grasp the meaning of mental *qualities* from a physiological point of view. From a psychological point of view we can understand how the mind may regulate and select, as it were, the nature of its retentions; but that intellectual operations, or the ways we ought to think, possess any structural advantages over the ordinary psychical activities, or ways we do think, is a question which we have not been able to determine. As yet, however, our knowledge of the anatomy and dynamical relations of the nerve-cells and their processes, is so meagre, and so incompletely representative of

* "Journ. Ment. Science," Oct., 1894, p. 678.

the complex, yet clear succession of mental operations, that the subject can only be left for future consideration.

Partial Amnesias.—It is commonly assumed that every recollection has its seat in a definite and determinate portion of the cerebral hemispheres. Each portion has its special function to perform, but is in intimate relation with its fellows. Ribot compares each particular form of memory with a contingent of clerks charged with a special and exclusive service. Any one of these departments might be abolished without serious detriment to the rest of the work, and that is what happens in partial disorders of the memory.

It seems unnecessary to dwell upon the fact, that no one is equally perfect in all departments of his memory. Some are unable to recall names, places, or events; others are deficient in their memory for tones or colours. Sometimes this deficiency is fully recognised by the individual, and the local memory for one series of events is habitually associated with that of another series in order to facilitate the process of recall. The forms of partial amnesia may be divided into two groups—viz.: (1) Those forms in which there is loss of memory of a series of mental states, without any obvious interference with the activities of the mind as a whole; (2) those forms in which the loss is due to disease or injury of certain nerve-elements. In the former group there may be temporary suspension of some of the mental functions; whilst, in the latter, there is destruction of some of them.

In a work of this description it would be out of place to consider fully all the questions involved in disorders of intellectual expression by speech and writing as met with in aphemia, agraphia, aphasia, amnesia, etc. We must, however, consider, together with those conditions in which there is aphasic loss or impairment in the power of speaking, with amnesic defects in writing, the cases in which there is aphasic loss of power of writing, with amnesic defects in speaking; and also the cases in which there are amnesic defects only in speech or writing, or in both. In amnesic patients, generally, there is difficulty in finding the right words, or wrong words are substituted. There is seldom any difficulty in repeating a word after it has been pronounced by some other person, showing that there is no difficulty in articulation.

From the point of view of localisation, amnesic defects of speech present great difficulties. We have many data which help us in localising aphasic conditions, whereas fuller information is required for the localisation of different amnesic defects.* Bastian† believes that lesions about the posterior extremity of the Sylvian fissure of the left hemisphere probably cause one or other variety of amnesia, as lesions of or about the third left frontal cause aphasia. The former region includes the angular gyrus, the supra-marginal lobule, and the posterior half of the upper temporal convolution.

* Bastian has formulated the following comprehensive scheme for the study of speech defects:—

Scheme for the Examination of Aphasic and Amnesic Persons.

Auditory Perceptive Centre, with its afferent and efferent fibres—

1. Hearing—good or bad? 2. Comprehension of speech. 3. Appreciation of vocal music. „ „ instrumental music	To test the functional activity of afferent fibres and of the centre itself.
4. Speech: (*a*) Imitative. (*b*) Associational (repetition of numerals, alphabet, days of week, etc.). (*c*) Spontaneous.	To test the functional activity of the centre and of its efferent fibres.

Visual Perceptive Centre, with its afferent and efferent fibres—

1. Sight—good or bad? 2. Comprehension of printed or written words. 3. Recognition of numerals or letters (as judged by ability to point them out). 4. Recognition of common objects. 5. Recognition of pictures of common objects.	To test the functional activity of afferent fibres and of the centre itself.
6. Writing: (*a*) Imitative (copying of numerals or letters, or "transfer copying" of letters or words). (*b*) Associational. (*c*) Spontaneous.	To test the functional activity of the centre and of its efferent fibres.

Commissures between the auditory and the visual centres (visuo-auditory and audito-visual)—

1. Naming at sight common objects, numerals, letters, or words.
   Reading aloud.
2. Writing from dictation, numerals, letters, words, or propositions.

† "Brain as an Organ of Mind," p. 682.

This view is supported on clinical and pathological grounds, and also from the fact that the posterior third of the hinder segment of the internal capsule conveys all the sensory impressions both general and special from one half of the body, and also because the fibres composing this posterior third of the hinder segment of the internal capsule (which lies between the posterior extremity of the lenticular nucleus and the posterior half of the thalamus) begin to be distributed to the convolutions in parts contiguous to the posterior extremity of the Sylvian fissure.

Of possible faults in the vocal and oral mechanisms we shall speak later, when we discuss motor aphasias. For the present we have to recognise that language is the instrument of thought. "It is," says Wyllie,* "the magic mirror in which a man may look and read the thoughts of another person, or into which he may cast his own thoughts for another's information. It was by the mind's own efforts that the mirror was originally polished and made efficient; and it is only by the mind's constant attention that it can be kept in good order for daily use. When the mind is damaged, the mirror truthfully reflects a damaged and distorted image. When the mirror is damaged, the reflected images of the mind is not a good and true one; it is blurred, if not distorted, owing to fault in the reflecting power of the mirror."

We have already discussed the question as to the revival of sense-images or memories that are supposed to have been stored up in the cortical centres belonging to the various senses. Each organ of sense must have its cortical area somewhere in the brain, and each centre must not only be instrumental in the reception of fresh impressions, but must also be the storehouse of former presentations and their associations. These storehouses must accommodate the material counterparts of sensations derived through the special senses and the kinæsthetic sense. As to whether the revived images are perceived in some supreme ideational centre, or whether they are perceived in what we regard as their own areas, we have already expressed an opinion. We have hitherto been unable to find a supreme ideational centre, and this itself leads

* "The Disorders of Speech," p. 183

us to favour the latter view. With our advance in knowledge of cerebral localisation we shall probably be able to settle this question more definitely. In the meantime, however, we repeat, that we do not know the minute anatomical relations between the storehouses of revivable images and the organs of perception.

Aphasia in one or other of its forms may be produced by affections of the ingoing or outgoing channels or centres, or of the commissural fibres between them. According to Wernicke, motor aphasia occurs if the motor centre is affected, and sensory aphasia if the sensory.

Clinically, the following forms are those which are more commonly met with :—*

1. *Ataxic aphasia* (Kussmaul), in which there is *loss of* volitional speech, repetition of words, reading aloud, volitional writing, and writing to dictation. The patient, however, is able to understand spoken language, written language, and possesses the faculty of copying. The lesion is at the centre for motor images.

2. *Sensorial aphasia* (Wernicke), in which there is *loss* of understanding of spoken and written language, inability to repeat words, to write to dictation, and to read aloud. The patient can write or copy words. Volitional speech is imperfect, and paraphasia may exist. The lesion is at the centre for auditory images.

3. *Commissural aphasia* (Wernicke) may occur as the result of lesions affecting the various commissural fibres. The chief forms are :—

(*a*) Lesions between the perception centre and the centre for motor images cause motor aphasia with loss of volitional speech and volitional writing, but the patient understands spoken and written language, and can copy. This variety differs from Broca's aphasia, in that the patient can repeat words, write to dictation, and read aloud.

(*b*) Lesions between the centre for motor images and speech apparatus cause Broca's aphasia, but the patient can write at will and to dictation. In some cases the thoughts can be expressed in writing, although the patient is unable to speak.

* Landois and Stirling, p. 712.

(*c*) Lesions between the centre for auditory images and the perception centre cause loss of understanding of spoken and written language; but there is volitional speech (paraphasia), volitional writing (paragraphia), the power of repeating words, of reading aloud, of writing to dictation, and of copying words. The patient, however, does not understand what he repeats, reads aloud, or copies.

In amnesic aphasia, should the patient hear a word, he is able to appreciate its full significance. Occasionally, only certain words are forgotten, or only parts of words are spoken. Kussmaul employs the term *paraphasia* for that condition in which there is inability to connect rightly the ideas with the proper words to express those ideas, so that, instead of giving expression to the proper ideas, the sense may be perverted, or the form of words may be unintelligible. *Agrammatism* and *ataxaphasia* are terms used to indicate the inability to form the words grammatically and to arrange them synthetically into sentences. Other conditions due to derangement of the cortex are described as *bradyphasia*, a pathological slow way of speaking; and *tumultus sermonis*, a pathological and stuttering way of reading.

The motor tract for speech passes along the upper edge of the Island of Reil, then into the substance of the hemispheres internal to the posterior edge of the knee of the internal capsule; thence it passes through the crusta of the left cerebral peduncle into the left half of the pons, where it crosses, then into the medulla oblongata. Total aphasia would result from total destruction of these paths; whilst *anarthria* (defect of articulation) would result from their partial destruction.

Word-blindness and word-deafness may occur alone or in conjunction with each other. A word-blind or word-deaf person is thought to resemble one who in early youth has learned a foreign tongue which he has completely forgotten at a later period. Words and written characters are heard or read, but the significance of the signs is lost. Wernicke found softening of the first temporo-sphenoidal convolution in all cases of word-deafness. Physical blindness is said to occur after injury or from disease of the lower parietal lobe.

Before we can fully understand the physical nature of language relations we must know more about the anatomical regions directly concerned with the perceptions derived through the so-called word-seeing, word-hearing, speech, and writing centres. This is the direction in which a certain amount of success is possible. As yet, however, the clinico-pathological evidences have thrown but little light upon those forms of amnesia which, psychologically considered, are impairments of the intellectual power.

Among the insane, one meets with nearly every variety of aphasia, ataxic and amnesic. Mental confusion, emotional states, transitory conditions of excitement, or even simple nervousness may produce paraphasia, agrammatism, or ataxaphasia. Bradyphasia, or tumultus sermonis, may occur as temporary conditions during some forms of mental disorder, or they may be symptomatic of cortical degeneration. Other conditions, such as verbigeration, stuttering, and stammering will be considered later. In general paralysis it is not uncommon to find that the patient has had in the early stages of the disease slight attacks of partial amnesia. Such attacks may consist in loss of memory for a class of events derived through the medium of any of the special senses; or there may be a temporary inability to recall special events. In states of nervous exhaustion or excessive fatigue an individual may fail to recall events or facts in a certain direction. Sometimes the mere volitional activity or concentration of effort involved in an attempt to recall a special event results in an intensification of that partial amnesia. Such an experience is known to everyone, and in not a few instances has this factor, excessive voluntary effort to recall, been the main cause of the amnesia.

Hypermnesic States.—The various states of exaltation of memory are of extreme interest psychologically, but up to the present time physiology has thrown little or no light upon their nature. Exaltations of memory may be general or partial. Sometimes the condition appears to be dependent upon physiological causes, such as increased rapidity of the cerebral circulation. More commonly, however, the cause appears to be pathological. Ribot has pointed out, that *general excitation* of the memory frequently appears in acute fevers, that it is still more common in maniacal excitement, in ecstasy, and in hypnotism, and that sometimes it appears in hysteria and in the early stages of certain diseases of the brain. Hypermnesic conditions are usually transitory.. Some cases have been described in which there has been permanent improvement of the memory after an acute fever or injury. *Temporary* exaltations not uncommonly arise in the early stages of acute psychoses. Thus, in general paralysis of the insane a temporary hypermnesia may precede a progressive amnesia, just as a hyperæsthesia may precede an anæsthesia. Various toxic deliriums are attended with hypermnesia. Poisoning by alcohol, lead, morphia, absinthe, ether, chloroform, chloral, haschisch, or cocaine, may present initial symptoms of exaltation, which precede the more grave mental disturbances.

The innumerable instances of *partial* hypermnesia have usually been associated with morbid mental states or with defects in the other mental faculties. Of the extraordinary examples of revivification of long forgotten facts, and of the various hypotheses which have been advanced to explain them, we could say much; but we refrain, inasmuch as the boundaries of our positive knowledge with regard to them are so limited.

In idiots, imbeciles, and geniuses, we find examples of excessive retentiveness of memory in certain limited directions. Forbes Winslow* quotes a case of a man who could remember the day when every person had been buried in the parish for thirty-five years, and could repeat with unvarying accuracy the name and age of the deceased, and the mourners at the funeral. "But he was a complete fool. Out of the line of burials he had not one idea, could not give an intelligible reply to a single question, nor be trusted even to feed himself."

A boy at the Royal Albert Asylum remembered accurately the name, date of entrance, and the amount of clothing of every patient admitted to the institution for many years. In other respects he was an idiot. Another patient, at the Earlswood Asylum, could give an account of historical facts and dates with extreme facility. On being questioned upon any historical subject, he showed evidence of being the possessor of a memory which was almost encyclopædic. In the Massachusetts Asylum, for the blind, a female deaf and blind mute

* "Obscure Diseases of the Brain and Mind," 1863, p. 586.

possessed an extraordinarily keen sense of smell. Anybody whom she had met before, she recognised by smell. She knew all her acquaintances by the smell of their hands. In sorting clothes that had come for the wash, she could distinguish those of each friend. If half a dozen strangers threw each his glove into a hat, and the gloves were mixed, she would take them up, and by means of smell alone assign them to their owners. Maudsley records the case of an idiot who could repeat accurately a page or more of any book which he had read years before, even though it was a book which he did not understand in the least. The proverbial memory of Macaulay, and that of Ben Jonson, who could repeat all that they had ever written, and whole books that they had read, are instances in which the memory itself was one of the essential elements of their genius. Niebuhr, Gibbon, Pascal, Leibnitz, Burke, Themistocles, and Cyrus, also possessed extraordinary memories.

It is difficult to imagine the physiological "process of association" which determines such phenomenal conditions. In these instances there is no constant repetition of the process of association which makes the connection easier. Bain believes, that in the nerve-cells, where the currents meet and join, there is, in consequence of the meeting, a strengthened connection or diminished obstruction; a preference track for that line over other lines where no continuity has been established. How far this hypothesis is adequate we have already inquired, and we do not deem it necessary to revert to the subject. Luys quotes the instance of a young married lady who had listened to one of his lectures, and who could repeat the lecture several months afterwards in a state of somnambulism. When awakened, however, she was utterly unable to repeat a single word of the lecture. She said she had not listened to it, she had not understood a word of it, and could not say a single line.

Paramnesia.—The various illusions of memory—where an individual believes that he has before experienced circumstances which are actually new to him—have been termed paramnesic states. Kraepelin* has grouped these states in three classes:—

* "Archiv. f. Psychiatrie," xvii. and xviii.

1. *Simple paramnesia*, a simple image which appears as a recollection. These illusions are very common in general paralysis of the insane. Thus, general paralytics will give marvellous accounts of what they have seen and what they have done, although the accounts have no real foundation in fact. In some forms of alcoholic insanity, it is not uncommon for the patient to give details of experiences imagined to have been undergone. One patient, at present in Bethlem, suffering from alcoholic peripheral neuritis, asserts positively that she has been out for a walk in the garden; whereas, she has been kept constantly in her bed. In some of these cases an illusion or hallucination may have been the initial factor in the production of the paramnesia, inasmuch as the confusion results from inability to distinguish between what was actually a false sensory perception and a perception having a foundation upon an objective reality. When there is revivification of an imagined image, the fact that the primary image was imaginary may be lost sight of, and the present revival appears to be based upon fact.

2. *Paramnesia by identification*, a new experience appears as the photography of a former one (Kraepelin). Some lunatics, brought for the first time into an asylum, have the feeling as if they had been there before and had seen the same persons on some former occasion.

According to Ribot, the illusion is easily explained. "The received impression evokes analogous impressions in the past—vague, confused, and scarcely tangible,—but sufficiently distinct to induce the belief that the new state is a repetition. There is a basis of resemblance between the two states of consciousness, which is readily perceived, and which leads to an imaginary identification. It is an error, but only in part, since there is really in the recorded impressions of the past something resembling a first experience. If this explanation is sufficient for very simple cases, there are others where it is inadmissible."

3. *Associated or suggested paramnesia*, "an actual impression suggests an illusion of the memory—a pseudo-recollection of something similar in the past." The explanation of the method by which actual impressions suggest illusions of the memory is at present unsatisfactory. We all experience the

condition of associated or suggested paramnesia, but it is more noticeable in those who are mentally unstable. Ribot suggests that the image is very intense and of the nature of a hallucination; it imposes itself upon the mind as a reality because there is nothing by which the illusion may be rectified. "Hence, the real impression is relegated to a secondary place as a recollection; it is localised in the past; wrongly, if the facts are considered in an objective sense; rightly, if we take the subjective view."

Before concluding this part of our subject, mention must be made of those somewhat rare and interesting conditions in which, although a patient may be suffering from dementia with inability to frame one coherent sentence, he yet, nevertheless, retains the power of playing as good a game at whist as ever; and, moreover, notes and remembers the cards played out. Such instances furnish us with difficulties which cannot be explained from either a physiological or pathological point of view. Later, we shall endeavour to harmonise some of the pathological conditions of memory with Hughlings-Jackson's scheme of factors of the insanities; but we shall see that his hypothesis is far from being sufficient to explain many of the variations in memory met with in the insane.

Some of our conclusions, then, in regard to memory must be as follows:—(1) We do not yet definitely know its seat in the cortex; (2) we do not know how mental impressions are fixed and retained; (3) we do not know how nutrition of the ever-changing brain-substance affects the exactness of the assimilation accomplished in the formative process; (4) we do not know the physiological conditions which cause either instability or fixation of recollections; (5) we do not understand how disintegration of molecular structures from too rapid combustion can determine amnesic states which can be recovered from (in such instances the memory is often completely regained); (6) the physiological explanation of the *organisation* of memory is incomprehensible; (7) we can conceive the variations and laws of memory only in their psychical aspects; (8) we *believe* that there must be some substantial counterpart of memory, but we are unable to understand its nature. The hypotheses that have been advanced to account for the new state, the organic registration, and the process of organisation, do not in reality prove adequate; and, lastly, (9) in the future our knowledge of the relations of various areas and tracts may help in the elucidation of the active processes of recall; but that we shall ever be able fully to explain the phenomenon of memory as a subjective state we do not deem possible.

The belief that feelings, ideas, and intellectual actions in general, are not fixed, and only become a portion of memory when there are corresponding residua in the nervous system, has gained ground considerably. Further, it is generally held, that on these conditions, and these only, can there be conservation and reproduction. We have already devoted a considerable amount of attention to the possibilities of the truth of such doctrines, and we are compelled to remain in a condition of uncertainty, because we are unable to form any conception as to what does take place. We do not wish to falsify existing truths, and thereby block the way to further knowledge; we merely wish to point out, that the doctrines which have been propounded are not in themselves adequate to meet the requirements of the mind.

In speculative physiology, little or no account is taken of the nature and laws of mind, and whilst, on the one hand, speculative psychology errs because it tends to ignore the infinite and varied functions of the brain, so, on the other hand, speculative physiology errs because it fails to appreciate the infinite varieties of phenomena that exist in the mind that perceives, thinks, imagines, remembers, feels, and wills. Lord Salisbury did well when he took a survey, not of our science, but of our ignorance. He pointed out, that we are living in a small bright oasis of knowledge, surrounded on all sides by a vast unexplored region of impenetrable mystery. Among the scientific enigmas which still, at the end of the nineteenth century, defy solution, he included the nature and origin of what are called the elements, the action of an unknown force on ordinary matter, as manifested in animal and vegetable life. To these we may add, the physiological activities which are regarded as being the counterparts of mind. Criticising Weismann's statement, "We accept natural selection because we must, because it is the only possible explanation that we can conceive," he said that, as a politician, he (Lord Salisbury) knew that argument very well. 'In political controversy it was sometimes said of a disputed proposal that it "holds the field," that it must be accepted because no possible alternative had been suggested. In politics there was occasionally a certain validity in the argument, for it sometimes happened that a definite course must be taken, even though no course was free from objection. But such a line of reasoning was utterly out of place in science. We were under no obligation to find a theory if the facts would not provide a sound one.' In these striking observations we find a complete shelter for all we have said about the fanciful hypotheses in the domain of physiology. The only difference between our position and that of Professor Weismann rests in the fact, that whereas he believes that we are able to demonstrate the processes of natural selection in detail, and can with more or less ease imagine them, we are totally unable to demonstrate any psycho-physical processes in detail. Further, when we try to imagine, or speculate upon, the transcendental aspects of these questions, our efforts prove unsatisfactory, and we are forced to rest content with that which is empirical and within the realms of human reason.

CHAPTER XII.

Feelings.

States of Feeling—Relation of Feeling to Knowing—Instincts and Emotions—Theory of the Emotions—Temperaments—Laws of Pleasure and Pain—Tone of Feeling—Physiological Theory of the Feelings—Feeling of Effort—Varieties of Feelings—Classifications.

Disorders of the Feelings and Emotions.

Sense Feelings—Feelings Connected with Ideas—Intellectual Feelings—Rational Feelings—Disorders of Childhood, Puberty, Adolescence.

FEELINGS.

Any state of consciousness which is pleasurable or painful is known as a state of feeling, and it is upheld by many, that every state of feeling has a pleasurable or painful aspect in some degree. Bain speaks of a *neutral* excitement; but, as Volkmann observes, it is difficult to understand how any feeling as such can be altogether uncoloured. Feelings have their objective, as well as their subjective, significance. They form the interesting side of life. Thus, they accompany the activities involved in intellectual operations, and furnish the mind with desires and motives for the exercise of volition. The absence or excess of feeling has much to do with the development of mind as a whole. The moral character, the intellectual character, and the active side of mental life, are intimately dependent upon its presence. When we study the human mind, we see, not only a combination of intellect, feeling, and will, but also, in a manner, we recognise objectively by observation, or subjectively by introspection, a varying inequality or preponderance of one or other of these psychic manifestations according to circumstances. It is rare to meet with perfect equality or equanimity; and, moreover, the preponderance of one psychic manifestation is commonly regarded as implying a decrease or impairment of one or other psychic state.

The relation of feeling to knowing has been clearly pointed out by Sully. It is impossible to carry out intellectual operations effectively, if, at the same moment, there is any strong emotional feeling. "All violent feeling takes possession of the mind, masters the attention, and precludes the due carrying out of the intellectual process." Thus, the emotional temperament is extremely difficult to train intellectually. On the other hand, a certain amount of interest or feeling is absolutely necessary for intellectual growth. As associated with higher feelings, or with complex sentiments, a certain degree of abstract thought is necessary. Hence, we see that the intellect and the emotions are to a certain extent essential to each other. The older psychologists held, that feeling and intellection were necessarily antagonistic to each other. Volkmann* argues, that there is a close connection between feeling and intellectual activity. Spencer upholds the view, that our feelings are to a large extent made up of confused representations of ancestral experiences. Horwicz† regards feeling as the primordial type of mental manifestation. Schneider,‡ on the other hand, believes, that in the simplest sensational consciousness there is involved a rudiment of intellection in the shape of the discrimination of a state as favourable or unfavourable. Ward, Wundt, Shopenhauer, and others appear to think that activity, impulse, or volition is the fundamental psychological phenomenon.

Some writers regard intellection as being essentially a reflex phenomenon, the excitation consisting in a presentative or representative stimulus. Feeling, as the invariable accompaniment of intellection, may, in a certain sense, be regarded as a reflex also; whilst volition, being the result of previous

* "Lehrbuch der Psychologie," vol. ii. sects. 127 and 129.

† "Psych. Anal.," Theil. i., Abschn vi., and Theil ii., Hälfte.

‡ "Der Menschliche Wille," cap. ix. p. 190 *et seq.;* and Ward, "Mind," vol. viii. 1883, p. 472.

acquisitions, intellectual or emotional, appears to be even more a reflex activity. We must assume that all intellectual, emotional, and volitional activities are intimately connected in mentalisation. Some urge that the two former (in their elementary states) are coincidental conditions, whilst the latter is a result. From another point of view, intellection is regarded as the outcome of volition or emotion.

It is difficult to draw a definite line between instincts and emotions. Their relation is very intimate, and conditions which excite the one, as a rule excite the other. According to James, emotions fall short of instincts, in that the emotional reaction usually terminates in the subject's own body, whilst the instinctive reaction is apt to go farther and enter into practical relations with the exciting object. He also gives the theory, that *bodily changes follow directly the perception of the exciting fact, and that our feeling of the same changes as they occur* is *the emotion.* Further, "every one of the bodily changes, whatsoever it be, is *felt*, acutely or obscurely, the moment it occurs. . . If we fancy some strong emotion, and then try to abstract from our consciousness of it all the feelings of its bodily symptoms, we find we have nothing left behind. . . . for *us*, emotion dissociated from all bodily feeling is inconceivable. . . . If such a theory is true, then each emotion is the resultant of a sum of elements, and each element is caused by a physiological process of a sort already well known. The elements are all organic changes, and each of them is the reflex effect of the exciting object. The moment the genesis of an emotion is accounted for, as the arousal by an object of a lot of reflex acts which are forthwith felt, we immediately see why there is no limit to the number of possible different emotions which may exist, and why the emotions of different individuals may vary indefinitely, both as to their constitution and as to objects which call them forth. . . . Any classification of the emotions is seen to be as true and as 'natural' as any other, if it only serves some purpose."

It is difficult to reconcile ourselves to this theory, and we feel that there are many instances which cannot he accounted for in this way. Thus, in various dream-states, it is hard to imagine that an intense emotional state is the result of any reflex effect of an exciting object. In our ordinary waking moments we may experience various emotional states without the slightest reference to any physical impressions: there may be none of those wide-spread bodily effects antecedent to the arousal of an emotion or emotional idea. We are all aware, that extremely rapid reflex acts may occur through immediate psychical influences, and that we subsequently experience the effects of those acts; but the *rapidity* of those immediate psychical influences does not warrant that we should lose sight of them altogether, and only take into account the reflex acts themselves. The best proof that the immediate cause of emotion is a physical effect on the nerves, is, according to James, furnished by those pathological cases in which the emotion is objectless. "It must be confessed, that there are cases of morbid fear in which objectively the heart is not much perturbed. These, however, fail to prove anything against our theory, for it is of course possible that the cortical centres normally percipient of dread as a complex of cardiac and other organic sensations due to real bodily change, should become *primarily* excited in brain-disease, and give rise to an hallucination of the changes being there—an hallucination of dread, consequently co-existent with a comparatively calm pulse, etc. I say it is possible, for I am ignorant of observations which might test the fact. Trance, ecstasy, etc., offer analogous examples, not to speak of ordinary dreaming. Under all these conditions, one might have the liveliest subjective feelings either of eye or ear, or of the more visceral and emotional sort, as a result of pure nerve-central activity; and yet, as I believe, with complete peripheral repose." *

Professor Lange, of Copenhagen, published, in 1884, a theory almost identical with that of Professor James. He considered the emotion to be the effect of the organic changes, muscular and visceral, of which the expression of the emotion consisted. The order of events was regarded to be as follows:—(1) An immediate reflex following upon the presence of the object, the organic change in question being regarded as the primary effect; (2) a secondary feeling indirectly aroused.

* "Psychology," vol. ii. p. 459.

Wundt* has severely criticised this view, and has pointed out that the same vaso-motor factors may be attended by totally different emotions—*e.g.*, joy and anger. Moreover, if a certain stimulus causes emotional expression by its mere reflex effects, why is it that another stimulus, almost identical with the first, will fail to do so if its *mental* effects are not the same ?†

The question would appear to be, Does the emotional excitement which follows the idea follow it immediately, or secondarily, and as a consequence of the diffusive "wave" of impulses around ?‡ If the diffusive wave of impulses causes the emotion, there ought to be some constant relation between the nature of the wave and the character of the emotion. The origin of an emotion would appear to be as follows :—(1) The objective qualities with which perception acquaints us affect us with pleasure or displeasure—*i.e.*, the perceptions are accompanied by a tone of feeling. (2) There may, or may not be, a physical reaction to the idea of the qualities of the object; this would determine the origin of the secondary sensations, which would constitute the emotion. Professor James merely advocates that such organic sensations being also presumably due to incoming currents, the result is that the whole of consciousness seems to be outwardly mediated by these. In

* "Philosophische Studien," vi., 1891, p. 349.

† It is difficult to imagine how an object *per se* can determine the physical effects apart from the subjective feeling towards the object. Irons ("Mind," p. 78, 1894) says, "If I were not afraid, the object would not be an object of terror." Worcester ("The Monist," 1893, vol. iii. p. 285) says, "Neither running nor any other of the symptoms of fear which he (Professor James) enumerates is the necessary result of seeing a bear. A chained or caged bear may excite only feelings of curiosity, and a well-armed hunter might experience only pleasurable feelings at meeting one loose in the woods. It is not, then, the perception of the bear that excites the movement of fear. We do not run from the bear unless we suppose him capable of doing us bodily injury. Why should the expectation of being eaten, for instance, set the muscles of our legs in motion? Common sense would be likely to say that it was because we object to being eaten; but, according to Professor James, the reason we dislike to be eaten is because we run away." In reply to the latter criticism, Professor James somewhat modifies his position, and agrees that the same bear may truly enough excite us either to fight or flight, according as he suggests an overpowering "idea" of his killing us, or of our killing him.

‡ "Psychological Review," vol. i. No. 5, p. 518.

short, this theory of the emotions applies *only to the rank feelings of excitement which are more especially derived from organic visceral reflex states.* The observations of Sollier* seem to confirm the view, that the rank emotions depend almost exclusively on visceral sensations.

We now turn to some other considerations which have engaged the attention of psychologists and mental physiologists. For an emotional type of character a lively imagination is a prerequisite. Unless the imagination is in full force, the life will be almost emotionless. Emotions are only slightly revivable in memory, and by repetition they tend to become more and more blunted.

Here it may be well to speak of those psycho-physical differences between men which are designated as temperaments. When we consider the four temperaments described by the ancients, we find that pathological conditions of the mind can be assigned to them with a certain amount of appropriateness. In general, the ancients found either a predominant spontaneity or a predominant receptivity. The former gave the active, the latter the passive, temperament, whilst, from the greater or less permanency of actions or impressions, they devised a fourfold subdivision. These four temperaments were:—(1) The *sanguine* or passive, with receptivity easily, but not deeply, affected; (2) the *melancholy*, with receptivity capable of being deeply affected; (3) the *choleric* or active, with quick, vigorous, but not durable, activity; and (4) the *phlegmatic*, with slow but enduring activity.†

The Laws of Pleasure and Pain.—It is almost universally held that some form of nervous activity is involved in every variety of pleasure and pain. Some writers refer only to the mental activities involved; others deal almost exclusively with the nervous accompaniments or activities of organs which either directly or indirectly affect the nerve-centres. Leibnitz regards the cognition of furthered vitality as the mode of mental activity which gives rise to feelings of pleasure. We may take it, that all sensations or feelings of pleasure involve a certain

* "Recherches sur les Rapports de la Sensibilité et de l'Emotion,"—"Revue Philosophique," March, 1894, vol. xxxvii. p. 241.

† Kant, "Anthrop.," p. 273; Feuchtersleben, "Medical Psychology," p. 144.

amount of mental activity and a reference to some physical state. The tone of feeling accompanies our sensations with varying degrees of intensity. Ziehen makes a sharp distinction between the tone of feeling which accompanies the sensation as such, and the tone of feeling that accompanies the ideas or images of memory, whose activity has no direct reference to the sensations. Sensations do not in themselves alone determine the various emotional feelings. The mental accompaniments of the various sensations usually derive their emotional tone from ideas and former acquisitions. The emotional tone of a sensation is, to a certain extent, dependent upon the intensity of the sensation in consciousness.

The relation of the strength of the stimulus to the degree of feeling has been formulated by Wundt,* who found that as soon as the stimulus passes the threshold and causes an appreciable sensation it begins to be pleasurable, and the pleasure goes on increasing as the stimulus is increased. At length a point or region of maximum pleasure is reached, which probably answers to that medium region of the scale where the finest discrimination is possible. From this point the pleasure rapidly diminishes till a certain point of indifference is reached. Above this, any further increase produces pain, which in its turn increases until it culminates as the maximum of pain is reached. This law is exemplified in all the higher senses. Horwicz† and Beneke have pointed out, that feelings of pain are sometimes associated with very weak sensations.‡ Wundt believes, that in this case the indifference-point is so low that it is no longer distinguishable from the threshold. In morbid states, such as melancholia, the law does not hold good. It is held that melancholic patients have usually painful feelings with every degree of sensation. It is a common observation, however, that with morbid mental depression there is often failure to respond normally to ordinary depressing causes, and we may formulate the general law, that *with the depth or degree of patho-*

* "Physiol. Psychologie," chap. x. sect. i.

† "Psychol. Analysen," s. ii. 2, 26.

‡ Ziehen, op. cit., p. 132. Cesca, "Die Lehre von der Natur der Gefühle." Vierteljschr. für wiss. Phil., 1886, x. Compare also Külpe, "Zur Theorie der Sinnlichen Gefühle."

logical melancholia there is an inverse degree of normal reaction to painful sensations or suggestions. For example, the reception of bad news has little or no emotional effect upon those who are already morbidly depressed. It is generally held, that a feeling of pain accompanies the slightest sensation, and that in conditions of melancholia there is painful response to much slighter intensities of sensation than in conditions of health. We hold that the opposite is true. Every sensation is received and coloured by a mind saturated with melancholic ideas, but the addition of such percepts, coloured though they may become, does not intensify the condition of depression. On the contrary, just as the addition of a clear fluid to a coloured one will tend to weaken the depth of that colour, so the addition of ordinary perceptions tends to dilute the condition of grief or pain in the melancholiac. Undoubtedly, sensations do become realised in consciousness as painful states, but with every realisation or reaction to normal influences, the morbid thought tends to become diluted, as it were, until, with the process of recovery, the individual responds normally to all stimuli from without. The law simply amounts to the fact, that with the rise of subject consciousness there is a corresponding diminution of object-consciousness—*i.e.*, the attention becomes absorbed by subjective sensations.

The tone of feeling which accompanies the various sensations is dependent, therefore, only to a certain extent upon the intensity of the sensation. Of the qualities of sensations as factors in the production of tones of feeling, we have little to add to what has already been said. The tone of feelings may be taken as dependent upon the intensity and quality of sensations, *plus* associated ideas.

Fechner* has called attention to the spatial arrangement of sensations as a factor in the determination of positive tones of feeling. The time-relationships of sensations, and their accompanying tone of feeling, have been clearly demonstrated by Ziehen. He points out, that we project our sensations into a *space* of three dimensions, while not only our sensations, but also their mental images (the ideas) are arranged with reference to *time* in but one direction.

* "Vorschule der Æsthetik." Th. i., Abschn xiv.

To explain how the tone of feeling accompanying sensations is dependent on their duration and succession in time, Ziehen says:—

"A long duration of sensation generally dampens both positive and negative tones of feeling. The manner in which several sensations follow one another in time only has an essential influence on the tone of feeling accompanying sensations of musical sound. A series of like sensations of tone, following one after the other, generally becomes wearisome; even when the quality of the tone changes an unpleasant feeling soon appears.

"In order to obtain the pleasurable feeling belonging to rhythmical division, either the intensity or the duration of the single tones must be subjected to a more or less regular periodic change. In musical tempo, and the versification of poetry, we have sequences of acoustic sensations, in which certain sensations are especially accented or intense, and all together have a definite duration. The qualities (*i.e.*, the notes and words) change, but the intensities of tone, the accentuations and diminutions, constantly recur at definite intervals or periodically. In poetry, the close of such rhythmical periods can often be emphatically marked by choosing very similar tones with which to close the periods. In this form of emphasis lies the importance of the rhythm.

"As regards the succession of sensations, therefore, a regular periodicity is the chief condition for the appearance of feelings of pleasure. It is not mere chance that maniacs and those afflicted with emotional paranoia often speak in rhythm and rhyme. Such phenomena harmonise rather with the morbid, positive emotional states characterising these forms of psychosis."

The contention with regard to the "tone of feeling" is, whether the feeling arises from the actual sensations, or whether the sensations are attended by a tone of feeling determined, for the most part, by ideas or images of memory. It seems that the latter condition is the more probable, and that the sensations themselves act by suggestion; the actual feelings being thus determined secondarily by association. Ziehen rightly believes, that only the intensity of the sensations and their succession in time and space have any direct effect upon their tone of feeling; hence, we may assume that the other qualitative characteristics of sensations derive their emotional tones from other influences which are wholly dependent upon psychical factors, apart from the sensations proper.

It is impossible here to re-enter into the question of the relationship of external stimuli to the various sensory structures. We must content ourselves with a few of the particular applications of the relationship. When the stimulus is inappropriate, painful states of feeling are apt to occur. There must be a certain proportion between the stimuli and the nervous activity. When the nervous structures are strained or abnormally active, or when their activity is impeded or defective, there may be an emotional accompaniment of displeasure; but, in general, we are more competent to explain the positive or negative variations in the emotional tone from the subjective side than from the consideration of the objective qualities of sensation.

The prolongation of any powerful mode of stimulation produces fatigue and the feeling of pain or displeasure. In order that the tone of feeling may continue as pleasurable, it is necessary that there should be limited duration of the stimulation, and variety or contrast of the impressions.

This law of the dependence of pleasure on change, has been the basis of most of the negative theories. Bain defines those emotions which depend on change of circumstances as "emotions of relativity"—*e.g.*, states of wonder, novelty, liberty, and power. The tone of feeling which accompanies stimulation of the bodily apparatus, furthers or retards organic processes. Thus, organic processes are promoted by cheerfulness of mind, or, conversely, healthy organic processes favour cheerfulness. When there is hindrance of activities, through over-taxation of organic processes, painful feelings are apt to arise; or over-taxation of the mental or emotional faculties leads to defective organic processes. According to Bain, pleasure is connected with an increase, pain with an abatement of the vital functions.*

* Spencer says, the pleasurable activity of any organ (*e.g.*, the palate, coincides in general with what is beneficial or life preserving to the organism. He regards pain as the correlative of actions injurious to the organism, whilst pleasure is the correlative of actions conducive to its welfare. He also holds it to be an inevitable deduction from the hypothesis of evolution, that races of sentient creatures could have come into existence under no other conditions. Psychologically, the intrinsic nature of pleasures and pains will ever prove vexed questions. In the meantime, we must agree with Spencer, who believes that while pleasures and pains are partly constituted of those local and conspicuous elements of feeling directly aroused by special stimuli, they are largely, if not mainly, composed of secondary

Before entering more fully into a consideration of the physiological theory of the feelings, it is important to recognise, that although the feelings primarily depend upon external agents, yet they are totally disparate in kind and degree. From a comparative point of view, we know that organisation in structure has much to do with the transmission of stimuli, and that subjective effects are qualitatively and quantitatively determined in some unknown way by objective stimuli; but the nature of these objective agencies are unknown. Spencer regards the peripherally-initiated feelings that arise in internal organs, and the centrally-initiated feelings or emotions, as having, also, their several forms of relativity. "Thus, the truth that subjective consciousness determined as it is, wholly by subjective nature, state, and circumstances, is no measure of objective existence. What we are conscious of as properties of matter are but subjective affections produced by objective agencies that are unknown and unknowable. All the sensations produced in us by environing things, are but symbols of actions out of ourselves, the nature of which we cannot even conceive."* Further, he concludes, as an obvious corollary from physiological truths, that it is inconceivable that any resemblance exists between the subjective effect and that objective cause which arouses it through the intermediation of changes resembling neither. "Not a step can be taken towards the truth, that our states of consciousness are the only things we can know, without postulating an unknown something beyond consciousness. The only thinkable proposition is, that the active antecedent of each primary feeling exists independently of consciousness." Having fully grasped the truth, that the feelings are subjective phenomena, and that they do not correspond, or resemble, any interactions or connections between outer agents, the student will be better able to understand that the feelings themselves are for us nothing but symbols of agencies which are beyond, or antecedent to, states of consciousness.

In order that feelings may be revived, certain fit states of

elements of feeling aroused indirectly by diffused stimulation of the nervous system.—(" Inductions of Psychology," p. 128.)

* "Epitome of Spencer's Synthetic Philosophy," by Collins, p. 207.

the organism are essential. Thus, we know from clinico-pathological observations, that defects in the circulatory system may abnormally hinder or promote the revivability of feelings. An active circulation and a blood which contains the required materials may favour the revivability; or a defective circulation and poor blood may effect an increase of revivability, but with a distortion of the relations between feelings. In acute maniacal states the feelings revived, and the consciousness of their relations, are often morbidly increased; but the quantitative increase of the former more commonly acts as a deterrent to the latter, especially when the latter are of the same nature as the former.

Thus far we have seen that the physiological counterpart or actual basis of the feelings is at present little determined. We know no special brain-centres which are concerned with the emotions; nor do we obtain any knowledge from the scientific investigations upon the presentations of sense or the time relations of mental phenomena.*

The attempt to give a physiological explanation of the origin and nature of the feelings, has proved unsatisfactory, and, as we have seen, such an attempt is valueless, because the purely mental states or "associative ideas" cannot be eliminated from consideration. The mere consciousness of certain conditions of the nervous elements, or the feeling of furtherance or hindrance of activities, does not form any really conceivable basis for the relations between the subjective and objective facts at our disposal. Ladd regards the theory, which makes feeling a derived consciousness dependent upon the relations of the ideas as furthering or checking each other, as unsatisfactory. Nor does he admit that feeling is a secondary or derived form of consciousness. Horwicz,† Lotze,‡ and Ladd uphold, that feeling is one of the most primitive and unanalysable of mental activities. The latter writer states, that feeling is an original and underived form of consciousness,

* Ladd says, that, "On these matters, nothing but the greatest caution is fitted to inspire confidence; the supreme wisdom is not infrequently a frank confession of ignorance or uncertainty."

† "Psychol. Analysen," i. p. 168f.

‡ "Medecin. Psychologie," p. 235f.

or mode of the operation of conscious mind. "It can neither be defined by, nor deduced from, sensation or ideation."

Attention has been given to the question as to whether the same nervous elements which have to do with sensations are also concerned with the accompanying tone of feeling. Lotze* believes that sensation and feeling are due to two forms of processes in the same nervous elements. Shiff and others believe that nervous impulses resulting in pain travel by more or less distinct paths. Both views may be more or less correct, but the difference between the perception of pain physically occasioned, and the tone of feeling accompanying sensations is so great psychologically, that for our purpose the contention is of little value. For the present we must confess that our knowledge of the physical basis of pleasurable or painful feeling is sadly deficient; it remains to be shown, whether a separate apparatus is involved or not. That a separate mechanism of end-organs, conducting nerve-tracts, and central areas exists for the feelings seems improbable, and the supporters of this theory will have to develop a cerebral association scheme for the revivability and relativity of the feelings in relation to, and yet distinct from, the ideational scheme. To account for the tone of feeling which accompanies sensations, and which is derived secondarily from associative ideas, physiology is silent; nor do we deem it probable that this part of the subject can ever be investigated with positive results.

The consideration of the affections and the emotions, or passions, involves at least three important particulars.† (1) The characteristic feeling which distinguishes each; (2) its relation to the train of ideas, and the changes induced in it by the ideas; (3) the relations to the different bodily organs, and the reflex effect of the changes in these organs upon both the feelings and the ideas. We know that there is a psychological connection between perceptions and feelings, but when we attempt to establish a physical basis for the union of the two series of facts, we utterly fail and get beyond our depth.

"Speaking generally," says Spencer, "feelings and the relations between feelings correspond to nerve-corpuscles and the fibres which connect nerve-corpuscles, or, rather, to the

* Op. cit. pp. 245 ff. † Ladd, "Phys. Psych.," p. 316.

molecular changes, of which nerve-corpuscles are the seats, and the molecular changes transmitted through fibres. The psychical relation between two feelings answers to the physical relation between two disturbed portions of grey matter, which are put in such direct or indirect communication that some discharge takes place between them."

Mercier regards the physical substratum of feeling as a very different matter.

"It is the discharge itself. The discharge at one end of a nerve-path is the physical substratum of one feeling. The discharge at the other end of the nerve-path is the physical substratum of another feeling, and the current from the one position to the other is the physical substratum of a thought. Now the current is fully accounted for by the discharges. A pressure at one position *plus* or *minus* the pressure at the other is sufficient (other things being equal) to determine the setting of a current from the one to the other. Here, then, the physical substratum of thought is complete. It needs upon these lines no further elucidation. But with the substratum of feeling it is otherwise. The current along the nerve-fibre cannot set up the discharge in both positions, and may not initiate it in either. Whence, then, comes the one discharge, and whither does the other go? Proximately, the one may be set up by discharges coming from other positions, and the other may go to set up similar discharges elsewhere, but ultimately these can be but one source and one outfall for every discharge. Traced to its origin, every discharge of grey matter is set up directly, or with more or less remote indirectness, by currents coming into the grey matter from without—by currents set up by the impact of external forces on the surface of the organism. Traced to its destination, every discharge of grey matter, with which the psychologist is directly concerned, expends itself in producing or altering muscular contraction—in action on the environment, or in modification of such action. And the physical substratum of feeling is a nervous discharge. Hence we are compelled to affirm that every feeling is conditioned, either by action of the environment on the organism, or by action of the organism on the environment; and this leads us to the expression of which we are in search. If the foregoing account of the physical substratum of feeling and of the relations of feeling to thought both when viewed introspectively, and when viewed as correspondence are correct, then it follows, that while thought is the establishment of a relation, feeling is the occurrence of a state; and that while thought is the correspondence of a relation in the organism with a relation in the environment, feeling is the correspondence of a state in the organism with an interaction between the organism and its environment."*

* "The Nervous System and the Mind," p. 265.

This account of the physical basis of the feelings must be accepted with reservation. It would appear that feeling is to be regarded as the symbol of an antecedent organic state, and that this organic state is determined by discharges within the grey matter. Of the nature and direction of these discharges we are left in complete ignorance. The mere terms "current" and "discharge" are held to be sufficiently explicit in themselves to warrant the construction of such a physical formula.

Let the student set himself the task of explaining in detail the physical formulæ of the so-called "higher feelings" involved in the contemplation of such complex reactions of the mind as found in the utilitarianism of Mill, or the intuitionalism of Calderwood. Then let him reduce to terms of discharge and nerve-currents those feelings associated with moral judgments, laws of individual life, and moral relations, conscience, duty or obligation, biological or psychological evolution, or the ethical philosophy of first cause, self-determination, self-realisation, or finite existence. The attempt will be made through the medium of the intellectual operations, and it will be discovered that the higher feelings are compounded of ideas, and that, therefore, the elementary components of these feelings must be the elementary components of ideas. Then the student will find that he is no better off than before, and that he has to resort to his imagination for the other details. We know nothing about the correspondence of inner and outer relations, nor do we know how one series of changes affects the other series. Tone of feeling is a psychological fact. The correspondence of external and organismal processes with that tone of feeling is inexplicable, and the nature of the external and organismal processes is a matter of pure speculation.

Many of the æsthetic feelings have been investigated from a physiological standpoint, and a rational conception of their origin and nature has been sought by the scientific study of the various presentations of sense. Wundt* has demonstrated, however, that many of the æsthetic feelings do not correspond to the sense-feelings, nor are they the outcome of mere compounding of such feelings. Æsthetic feelings, according to

* "Phys. Psych.," ii. p. 179 f.

Ladd, may be said to arise from the manner of the combination of sensuous feelings; time and space furnish the framework in which they are arranged.

The feeling of effort associated with the performance of certain acts has been the subject of much controversy of late. We have already alluded to the anatomical relations of the so-called muscular sense, so that it only remains for us to discuss some of its central relations. Müller* regarded the nervous process to be purely central, and to consist in an efferent discharge. Bain and Wundt have adopted somewhat similar views. Ferrier and many others, however, believe that the feeling of effort is a complex of afferent sensations. From the observations already made, we are inclined to adopt the latter view, and to believe that the feeling of effort, with its tone of feeling, is mainly determined by peripherally incited afferent excitations. The further consideration of this subject will be taken up when we discuss the phenomenon of the will.

Paulhan† believes that the emotions are due to an inhibition of impulsive tendencies. James points out, however, that some kinds of emotion—namely, uneasiness, annoyance, distress—do occur when definite impulsive tendencies are checked, but that other emotions are themselves primary impulsive tendencies of a diffusive sort (involving a multiplicity of phenomena), and just in proportion as more and more of these multiple tendencies are checked, and replaced by some few narrow forms of discharge, does the original emotion tend to disappear.‡ Darwin, Spencer, James, and others regard the physical expressions of the emotions as being weakened revivals of movements which formerly were useful and necessary for the defence and survival of the subject. Another principle, mentioned by Darwin, and emphasised by James, is called "The principle of reacting similarly to analogous-feeling stimuli." The latter writer, in summing up the whole question of the genesis of the emotions, says, "We see the reason for a few emotional reactions; for others a possible species of reason may be guessed, but others remain for which no plausible

* "Physiologie d. Menschen, ii. p. 500.

† "Les Phénomènes Affectifs et les Lois de leur Apparition."

‡ Op. cit., p. 477.

reason can even be conceived. These may be reactions which are purely mechanical results of the way in which our nervous centres are framed—reactions which, although permanent in us now, may be called accidental as far as their origin goes. In fact, in an organism as complex as the nervous system, there *must* be many such reactions, incidental to others, involved for utility's sake, but which would never themselves have been evolved independently, for any utility they might possess. Sea-sickness, the love of music, of the various intoxicants, nay, the entire æsthetic life of man, we have already traced to this accidental origin. It would be foolish to suppose that none of the reactions called emotional could have arisen in this *quasi*-accidental way."

That the movements involved in expression often give a clue to the inner mental life, is perfectly true; but the correspondence between physiognomical and mental phenomena is variable, and physical expressions may be entirely independent of any prevailing tone of feeling or emotion. Meynert argues, that the movements of expression vary with the emotions; therefore these movements must be either of an aggressive or repulsive character. According to this observer, physiognomical expression is chiefly a matter of secondary presentations, which are evolved, like dream-presentations, during the condition of partial sleep, and that expression is dependent altogether upon the simultaneous excitation of such secondary presentations as are associated with our emotions or our thoughts.

The complicated system of physical expression, comprising facial movement, attitude, gesture, and intonation, has been elaborated chiefly by Bain, to whose labours in this direction the reader is referred for detailed explanations. Space will not permit us to take any further account of the innumerable controversies which have arisen in connection with the physical occasions of the emotions. It must suffice, for the present, to recognise that all the explanations hitherto rendered by the workers in this field have been as general hypotheses of operative potentialities. The accounts of structures and their related dynamical operations, though meagre in the extreme. and the constitution of the physical scheme, expressed in terms of matter and modes of motion, may widen the range of our imagination; but we cannot, in the light of the above generalisations, satisfy ourselves that we have in reality made much advance since the time when Aristotle, with his wonderful psychological insight, anticipated the modern empirical school of thought, and promulgated the doctrine that all knowledge was to be traced to sense and association.

Varieties of Feelings.—When we attempt to dissociate the rank feelings from all bodily or sentient experiences, we find that we are without material to explain their genesis, and, moreover, the necessary conditions which express their nature are absent also. That is to say, we so habitually refer to the bodily accompaniments or expressions of the feelings when we experience a state of feeling, that the two (the mental state and the bodily expression) cannot be dissociated. The fact that we do not know how our emotions are conditioned by nervous processes, need not stand in the way of our belief, that each emotion is in some way or other the result of a sum of activities or physiological processes. The causal relation of emotions is beyond us, and when we enumerate or describe their varieties, we do not imply more than, that certain mental states have certain bodily accompaniments which undoubtedly derive their reflex effects from organic changes peripherally or centrally initiated.

When we take into account the infinite number and variety of reflex acts which may occur in the adjustment of our physical organism to its environment, we see that the number of emotions symbolic of that adjustment is without limit. Among the insane, we meet with every variety of emotional accompaniment due to absence, exaltation, or perversion of reflex activity. Lange has pointed out, that some men are dumb, instead of talkative, with joy. Fright sometimes drives the blood into the head of its victim, instead of making him pale. Grief may cause an individual to run restlessly about lamenting instead of sitting down and becoming mute.

From what we have already said, the student will no doubt agree, that any one classification of the emotions or feelings is as useful and as natural as any other, if it only serves some purpose. It may be advisable here, however, to mention briefly some of the methods of classification adopted by various writers.

Sully classifies the varieties of feeling into two main divisions, as follows:—

1. *Sense feelings.*—(1) Those arising immediately from a process of nerve-stimulation, more particularly the excitation of sensory (incarrying) nerves; and (2) those depending on some mode of mental activity.

2. *Emotions and their classes* (arranged in a series or ascending scale, according to their degree or complexity, or representativeness.).—The order of their development is: (1) The individual or personal emotions (the pleasures of hope, success, reputation, etc.; (2) the sympathetic feelings (the participation in others' pleasurable and painful experiences, and kindliness or benevolence of disposition generally); (3) the sentiments, (*a*) intellectual, (*b*) æsthetic, (*c*) moral.

Herbert Spencer divides the emotions according to the degree of intellectual activity or representativeness involved.

1. *Presentative feelings.*—Ordinarily called sensations. Those mental states in which, instead of regarding a corporeal impression as of this or that kind, or as located here or there, we contemplate it in itself as pleasure or pain—*e.g.*, in inhaling a perfume.

2. *Presentative-representative feelings.*—A sensation, group of sensations, or group of sensations and ideas, arouses a vast aggregation of represented sensations, partly of individual experience, but chiefly deeper than individual experience, and consequently indefinite—*e.g.*, terror.

3. *Representative feelings.*—Revived sense-feelings. Comprehending the ideas of the feelings above classed, when they are called up apart from the appropriate external excitements. The feelings so represented may either be simple ones of the kinds first named (as tastes, colours, sounds, etc.), or they may be involved ones of the kinds last named (as poetical fancies, etc.).

4. *Re-representative feelings.*—Involving a more complex or abstract form of representation (as the sentiment of property or of justice). More complex sentient states that are less the direct results of external excitements than the indirect or reflex results of them. It is the abstract of many concrete representations, and so is re-representative (imagination).

Spencer classifies feelings from a standpoint mainly subjective. Bain objects to Spencer's system, and arranges the feelings with reference to the external circumstances with which they correspond. Viewed subjectively, feelings have been described according as they are founded on distinctions between their qualities. The following are some of the chief methods of classification :—*

Appetites, desires, affections (Reid).

Subsidiary faculties, and elaborative faculty (Hamilton).

Sensual feeling, intellectual feeling (Kant).

Harmony, conflict (Herbart).

Affections, moods, passions (Wundt).

Direct, reflective, and imaginative emotions (Hodgson).

Coupland, following in the lines of Spencer, bases his classification on the degree of representativeness of the underlying cognitive fact. He speaks of feelings which arise in connection with presentations known as "corporeal," those termed representative or associative, and those re-representative states where every vestige of personal reference has been eliminated, and the pleasure attaches to an object of the pure intellect. Mercier, objecting to the classification of Spencer as "too vague to be of any real service," has constructed a scheme which, in our opinion, is of still less practical value, inasmuch as it involves many assumptions which are doubtful psychologically. Ladd has severely criticised Mercier's scheme, and rightly condemns its "uncouth" terminology, artificial distinctions, and cross divisions.

For students' purposes, however, we give his scheme which is based upon the main classes of interactions between the environment and the organism, viz. :—

I. Those which primarily affect the conservation of the organism.

II. Those which primarily affect the perpetuation of the race.

III. Those which primarily affect the common welfare.

IV. Those which primarily affect the welfare of others.

V. Those which are neither conservative nor destructive.

VI. Feelings corresponding with relations between interactions.

* Mercier, "The Nervous System and the Mind," p. 286.

Before entering upon the question of the morbid emotional states, it is essential that we should better understand the subjective nature of some of the complex feelings, such as sympathy, and the intellectual, æsthetic, and moral sentiments. *Sympathy* involves the noting of objective facts in others, and the comparison of the objective signs, with the like conditions, in ourselves—*i.e.*, sympathy involves the constructive imagination of the feelings of others in ourselves. Thus, it depends upon the quickness of our observation, the nature and extent of our own feelings, and the imaginativeness we possess. Sympathy is further aided by similarity as to temperament, experience, and age between the objects and ourselves. Association, daily concourse, and personal liking also favour it.

The intellectual operations and the sentiments associated with them may be impartial or egoistic. The impartial submerge their individuality in the contemplation of the object; the latter exalt their individuality, and tend to render their contemplation of the object imperfect. For illustrations we have only to glance at some of the scientific and philosophical literature of the day.

The æsthetic sentiments are associated with presentations derived through the medium of the special senses. Their elements have been regarded as sensuous, perceptual, correlative, and associative.

The moral sentiments have been divided into those which are concerned with social questions of obligation, and conduct in life. It is impossible here to discuss the question as to the origin of moral sentiments, for we cannot enter upon such extensive subjects as those of intuitionalism or utilitarianism. The controversy as to whether the moral sentiments are the outgrowth of simpler feelings, or whether they are entirely dependent upon the modelling of environmental condition, is one which belongs to the domain of the Philosophy of Ethics.

DISORDERS OF THE FEELINGS AND EMOTIONS.

Changes or disturbances in some part of the organism itself may act as primary factors in determining morbid feelings.

The organic sense-feelings are usually vague as to their nature and locality; thus differing from the feelings which arise in connection with stimulation of the special senses. In conditions such as *euphoria* and its opposite, *malaise*, the sum of all the organic feelings constitutes their basis. The general feeling of well-being or ill-being has much to do with the dominant tone of feeling or mental tone at any one time.

We have already alluded to the temperaments, and we have noted that each type is characterised by its dominant tones of feeling. We have also noted that highly emotional states tend to interfere with the due activity of intellectual processes. Some individuals are incapable of effective intellectual work, owing to excessive emotional accompaniments. Others, again, have little intellectual emotion, and follow their pursuits with little or no emotional tone of feeling. The close connection between feeling and intellectual activity, and their mutual furtherance and hindrance, is liable to certain exceptions. Thus, some individuals possess finely developed intellectual activity with the keenest power of abstract thought, who, nevertheless, are deficient in one or all of the higher emotions, such as the moral sentiment, or the love of truth.

In psychological works much attention has been devoted to the correlations between states of feeling and certain bodily accompaniments, and innumerable examples have been given of the bodily manifestations with which the mental states are supposed to coincide. Many writers uphold the view, that when the physical manifestations of a feeling are cut off, the emotional excitement is greatly checked, and tends to subside. That this holds true in some forms of melancholia with agitation, is evidenced by the fact, that mechanical restraint is often attended by relief of the mental distress. Such patients not uncommonly request that their actions may be restrained, and they volunteer the statement that the mental relief is the result of the inhibition of their physical activities. In resistive melancholia, on the other hand, any attempt to control the movements sometimes results in an increase of the mental distress.

The relation of the expression of misery to the actual existing state of mind in an insane individual is always interesting. Those physical changes which have concomitant sense-feelings, including the movements of expression which are partly instinctive, partly acquired, not infrequently outlast the emotion in duration, so that the expressions themselves become continuous or automatic, whilst the mind derives its emotional tone from other sources. Everyone who has to deal with the insane can recall instances of movements expressive of misery occurring coincidently with pleasurable emotions. In such cases, the continuation of the emotion and of its expression along the same mental and physical lines respectively, result in a wearing out or subsidence of the former, and an automatic or unconscious repetition of the latter. Spencer believes, that as the feeling rises in intensity it engages muscles of larger and larger calibre. Volkmann* points out, that the uncontrolled expression of a feeling tends to expedite its subsidence. This he explains by the consideration, that the movements carried out in this case cause a loss of intensity in the sensations accompanying the emotion. We are unable to confirm the theory of Bain, that pleasure is connected with an increase, and pain with a decrease, in the vital energies. One has only to walk through the wards of an asylum to arrive at the conclusion, that euphoria and malaise are not proportionate to vital activities; at least, not so far as the *expressions* of the vital activities are concerned.

In the insane, many emotional states are found to be associated with some delusion which has obviously been determined by morbid physical conditions. Thus, one individual now in Bethlem is depressed because he believes that he was formerly made of chalk, but now, since taking some vinegar, he is "only in solution," and fears he may be emptied away. This patient was a chemist, and was aware that he had taken chalk mixture on former occasions. In such instances, the question naturally arises, How far may the character of the delusion be attributed to the emotional tone, or *vice versâ?* We have already seen that emotional tone in the insane can scarcely be conceived upon Wundt's scale of intensity of excitation, nor can we elucidate the occasion of painful states by an analysis of stimuli, appropriate or otherwise. In general, we conform to the law, that pleasure depends on a due balance between the

* "Lehrbuch der Psychologie," vol. ii. § 129.

process of stimulation on the one hand, and that of reinvigoration on the other; or between the expenditure and the accumulation of energy; but when we view the morbid states of feeling arising in connection with exhaustive diseases, and note the insane euphoria and exaltation that accompany the progressive depression of the vital functions, we feel that there is something more than the accumulation and transformation of potential energy into living force.

The law of Weber in relation to the ratio of increase of stimulus to that of sensation, has been pointed out by Fechner as bearing a certain analogy to the ratio of increase of pleasurable stimulus to increase of pleasure. In the melancholiac, the greater the depression the greater is the amount of depressing influence necessary in order to produce a perceptible increase. In some hysterical and hypochondriacal persons the accommodation of the mind to painful impressions, in time results in an acquired liking for what was formerly disagreeable. Thus, just as the sound of the bag-pipes may primarily affect us in a disagreeable manner, but ultimately become pleasurable, so the experience of a painful emotion may by repetition become essential to, and form part of, a mental state that is pleasurable. It is familiar to everyone how the melancholiac or hypochondriac will "hug" his delusion, and resent any cheerful interpretation of his feelings. With the repetition of sensations and ideas, with their accompanying tones of feeling, be they either pleasurable or painful, there arises *habituation;* and removal of the customary stimuli is attended by a corresponding want or negative pain, which has been termed "craving." The effects of change and habit on pleasures and pains form an interesting study, but one to which, in a work of this description, we are unable to devote attention.

The intimate connection between the activities of the various organs of the body, and the tone of feeling associated with the perception of those activities, furnishes us with innumerable data whereon we might base many descriptions and possible explanations of the morbid phenomena in the insane. It must suffice, however, to recognise, that the activity of any organ does not necessarily coincide with the tone of feeling prevailing at the time.

We have devoted a considerable amount of attention to the sense-feelings, and we have discussed the nature of the relation between the sense-organs and the mind. It will be unnecessary, therefore, to revert to this subject. In the insane, and more especially in hypochondriacs, there is often a morbid intensification of the organic feelings; and where these are susceptible of localisation, their import is generally exaggerated or misinterpreted.

In regard to the various disturbances of feeling most commonly met with, we may note the following as the normal foundations from which variations occur:—

The feelings proper (emotional).

The feelings referring to the will (volitional).

The feelings bearing upon thought (intellectual).

Mixed feelings, including forethought, desire, and relief.*

The feelings of *happiness* or *misery* are derived from physical and mental agencies. On the physical side, we have the various causes already enumerated; on the mental side, we have numerous examples of a degree or intensity in the happiness or misery. General paralytics usually receive sensations and revived impressions in the aggregate as pleasurable. Similarly, acutely maniacal patients are affected pleasurably rather than painfully. Melancholiacs, on the other hand, seldom experience pleasurable emotions, and, in the aggregate, their sum total of feeling is painful. Indifference to pleasure or pain is seen in the demented, the stuporose, and in the advanced general paralytic. The volitional feelings are subject to morbid perversions, as seen in those who are unable to control their morbid cravings, desires, or lusts; or in those who suffer from conflicting operations of the will. Intellectual feelings, or feelings associated with intellectual pursuits, may be absent or morbidly exaggerated. The mutual furtherance or hindrance of the two activities is evidenced in every asylum. Broadly speaking, the male lunatic's intellect perverts his feeling; whereas the female lunatic's feeling perverts her intellect. The former feels because he knows, and therefore believes; the latter feels, and therefore both knows and believes. The one says, "I know. It is not a question of feeling." The

* Bain, "Mental and Moral Science," p. 217.

other says, "I feel—therefore I know." The practical outcome of this broad generalisation is evidenced in the fact, that rational treatment by logical methods is sometimes effective with the former, seldom of any use with the latter. Mixed feelings involve memories of past events and former mental states. As pointed out by Bain, the state of desire grows out of the retentiveness of the mind for pleasure or pain. Conditions of belief are sometimes dependent merely upon feelings of the mind, and with their development the intellect has had little to do.

Let us now, however, look more particularly at some of the morbid emotional conditions met with in the insane. For convenience, we will note those perversions associated with:—

I. Sense-feelings.
   (*a*) Connected with bodily existence (health, depression, hunger, etc.)
   (*b*) Organic (feelings of special sense).
   (*c*) Inner sense (temper or high spirits).

II. Feelings connected with ideas.
   (*a*) Ideas from sense (disgust, sympathy with pain).
   (*b*) From imagination (hope and fear).
   (*c*) From understanding (shame, reproach, etc.)
   (*d*) The æsthetic feelings (physical beauty).

III. Intellectual feelings.
   (*a*) From acquiring knowledge (pain of idleness).
   (*b*) From intellectual exercise (novelty, system, order, symmetry, harmony, rhythm, simple and complex, wit and humour, comic and ridiculous).

IV. Rational feelings.
   (*a*) Truth feelings.
   (*b*) The higher æsthetic feelings.
   (*c*) Moral feelings.
   (*d*) Sympathetic feelings.
   (*e*) Religious feelings.

The feelings associated with bodily existence in the insane have much to do with the colouring of the mind. The true bodily state which most favours a feeling of health is that in which organic sensations are absent. The transition from a painful state to one which is pleasurable—*e.g.*, the feeling of satisfaction when hunger is appeased—does not negative this general statement. Further, other things being equal, the existence of a positive organic sense-feeling is attended by a proportional feeling of uneasiness or displeasure. In the sane person, therefore, visceral consciousness is proportionately painful. In the insane, the dominant feeling existing at the time may override or even obliterate the natural accompaniments; so that a positive organic sense-feeling becomes distinctly pleasurable. Thus, in general paralysis, we have seen many examples of exaltation and feelings of satisfaction derived mainly through the existence of morbid visceral states—*e.g.*, one patient suffering from constipation derived extreme satisfaction from the belief that he was the happy possessor of "millions of fæces." Another, suffering from anasarca, magnified his abdomen into the "abdomen of the Deity," and exhibited it with great self-gratification. In general paralytics, the organic sense-feelings, which are symbols of hunger, are sometimes absent. Such patients fail to appreciate when they have had enough food, and exhibit a boulimia, which is characteristic. Some idiots are unhappy unless there is complete distension of the abdomen by an excessive supply of nutriment, and instances have been known where the conditions of rumination are essential to the feelings of well-being.

The morbid exaggerations and excessive emotional accompaniments of the activities of the special senses, are well illustrated in some forms of hysteria. The emotional displays associated with unstable temperaments are often suggested by some simple sense-feeling. Thus, music is in some instances a potent factor in causing an outburst of emotion. The unequal development of the special senses, and the fact that cultivation of one sense in excess of the others involves with it feelings of a more advanced and suggestive order when that sense is active, helps to explain the sensory side of the many varieties of the special sense-feelings. In degenerative cerebral states, it is not uncommon to have a partial exaltation of feeling associated with the activity of a special sense; especially in the early stages of general paralysis and organic or senile dementia. In acute mania, there is often, with the hyperæsthesia of the senses, an exaggerated emotional accompaniment. In melancholia, in confusional states, and in anergic or melancholic stupor, the emotional accompaniment proper may be defective or entirely absent.

Those inner sense-feelings known as temper, high or low spirits, are met with in every degree of intensity in the various forms of insanity. In some forms of idiocy, as in the Mongol or Kalmuc, continuous amiability and placidity are noticeable. In monomaniacal states, there is frequently a stability of the inner sense-feelings, in striking contrast to the nature of the delusions—*i.e.*, there is no proportional feeling accompaniment. In hereditary neuroses, instability of the emotional side of mind is a noticeable symptom. Individuals who have inherited a neurotic diathesis are often subject to the periodical preponderance of sorrowful or depressed feelings, or feelings of a gay or expansive kind.

In senile decay, the emotional element is often perverted. An attack of senile mania may be ushered in by emotional instability without any obvious enfeeblement of the intellectual faculties. Depression of spirits may precede an attack of senile mania. The emotional disturbances may or may not be symptomatic of the onset of dementia due to gross lesions of the cerebrum. In cerebral atrophy, focal lesions, hæmorrhage, or thrombosis, the perverted state of the emotions is sometimes characteristic. Bevan Lewis draws attention to the diagnostic distinctions between simple senile depression as a purely functional ailment, and the depression which indicates a serious structural change in the nervous centres. He found, that in the forms of simple melancholia, unaccompanied by any delusional state, there was a strongly-marked suicidal tendency in 79 per cent.

In general paralysis, the emotional condition is also characterised by its instability. The prodromata of the disease may consist in emotional depression or excitement; the two conditions may alternate, each state being determined by insignificant causes. Sooner or later, however, the condition of euphoria predominates, and later that of complete absence of emotional tone. Those feelings connected with ideas in part derived from the senses—*e.g.*, disgust, etc.—are seen chiefly in the so-called delusional insanities. The utter contempt with which the victims of imaginary plots treat others around them is often a noticeable feature of asylum life. With such patients no attempt is made to conceal or control their expressions of disgust. On examination, some sense-perversion is usually found to account for the conduct. It may be due to an imaginary persecution by means of drugs or other substances, or there may be some delusion about the moral attributes of others. Sexual ideas give rise to many expressions of disgust, and in every asylum there is some individual who attributes unworthy motives or actions to those in attendance. These uncontrolled expressions, sometimes of actual loathing, are seen even in idiots, who make false accusations of immorality and disgusting conduct in others. In melancholiacs, the intense feelings of disgust are sometimes the outcome of ideas of unworthiness relating to themselves. Such patients refuse to shake hands, recoil when approached, and adopt every means within their power to avoid contaminating others. Similarly, the hypochondriac with ideas that he is suffering from a foul disease, that his breath is offensive, that he is covered with vermin, etc., will hold himself aloof from others, and avoid all possibilities of contact. In adolescent mania with exaltation, just as in the evolution of conceit, the individual will often treat his superiors with contempt. Such conduct, however, is as common outside asylums as within.

The absence of feelings of disgust is also characteristic of some forms of insanity. Thus, in some forms of mania there is loss of all the higher feelings of cleanliness or decency. Similarly, in states of dementia, melancholia, or stupor, there may be absence of attention to the ordinary conventionalities of society or the decencies of life. It is not uncommon to meet with cases in which this absence of conventionalism is the only characteristic feature of the mental attack. In idiots the moral side of the question may be defective from the beginning. In insanity it may be symptomatic, or it may remain as a sequel after an acute cerebral attack. In general paralysis it is sometimes seen in an extreme degree.

Sympathy, depending as it does upon a fine observation, rightness of interpretations of the objective signs, the recalling of past personal emotions, and the constructive imagination, is liable to defects or perversions, through absence, excess, or alteration of one of these factors. Some individuals possess an intense emotional temperament, and are susceptible in an exaggerated degree to the influence of the emotions of others. Others are deficient in emotional capacity and have little or no sympathy. There is a large field for study in the emotions of the insane.

We may say briefly; (1) Emotional and sympathetic states may be evidences of a natural temperament in the sane; or their existence may be symptomatic of mental perversion. Thus, the emotional susceptibility of a normal character in one individual may, in another, be unusual and pathological. In determining the value of the affection of the sympathetic capacity as a sign of disease, comparison must be made with the life history and emotional tendencies of the individual. Benevolence and pity may be natural or morbid. It must not be forgotten, however, that in some forms of mental disease (*e.g.*, general paralysis) the wide sympathies and benevolence may be the mere exaggerations of a natural temperament. (2) Fineness of observation has much to do with the absence or excess of the sympathetic feelings. Reference to the preceding chapters upon the senses will enable the student to appreciate, that just as the cognitive state varies with the functional activity of the senses, so the accompanying tone of feeling may be proportionately varied. In conditions of anæsthesia or hyperæsthesia the sympathetic feelings, other things being equal, will more or less coincide with intellectual interpretation of the presentations. (3) The mind's interpretation of the presentation is a factor of much importance, and the sympathy will vary with the rightness of that interpretation. We have already discussed the factors which give rise to abnormal interpretation, so that it is unnecessary to return to the subject. (4) The recalling of past experiences is productive of morbid exaggerations, or the reverse. Thus, just as want of sympathy with the emotional experiences of the young is in great part due to the fact that we have forgotten our experiences when children, so the apparent callousness of the general paralytic, the alcoholic, or the senile dement, is in part due to an amnesic state and inability to revive the emotional experiences of the past. That the sorrow of another should engage our sympathy it is essential that we should be able to compare the cause and effects of that sorrow with our own experience. (5) In addition to the revivability of our own impressions and their emotional accompaniments, constructive imagination is an important factor. Absence of this prevents a correct interpretation of the feelings of others. Exaggeration, on the other hand, betokens a susceptibility that is morbid. The absence, excess, or perversion of the sympathetic feelings, when viewed as the outcome or accompaniment of the various cognitive states, is a subject which might be dealt with at greater length.

Those *feelings connected with ideas* of hope and fear, involve a considerable amount of imagination. The hopes and ambitions in the insane are capable of modification. We have already pointed out, that the hopes which arise during periods of distress are sometimes realised by the general paralytic, and that the realisation is illusory, indicating thereby a process of dissolution. The illusory hopes of the phthisical are well known. Similarly, in chronic cerebral diseases, the condition of buoyancy and hope may be symptomatic. In adolescents we meet with every degree of hope, from mere desire to complete confidence and assurance. In old maids and others, the non-realisation of long-sustained hopes may result in a despondency that is morbid. In unstable temperaments, there is often rapid fluctuations between states of hope and despondency.*

* To the morbid states of fear numerous names have been given. *Amaxophobia* signifies a morbid fear of being in a waggon or cart; *claustrophobia*, fear of being in any closed space or chamber; *batophobia*, a morbid fear of heights; *agoraphobia*, a fear of open spaces. Beard ("Tuke's Dict.," p. 844) has classified certain conditions of fear according to their causes, as follows:—*monophobia*, fear as such; *anthropophobia*, the fear of being with others; *pathophobia*, the fear of becoming ill; *pantophobia*, fear of everything; *astrophobia*, fear of lightning; *rupophobia* (verga), the fear of being dirty; *siderodromophobia*, the fear of going by train; *nyctophobia*, the fear of night; *phobophobia*, the fear of becoming afraid. Arndt suggests that were we to carry this absurdity further, we might distinguish a much greater number of conditions of fear: *skopophobia* and *klopsophobia*, the fear of spies and thieves; *thanatophobia*, the fear of death; *necrophobia*, fear of the dead and of phantasms; *triakaidekaphobia*, the fear of number thirteen, etc.

The feelings of shame, reproach, etc., may be absent, or morbidly intensified. The maniacal person suffers little from feelings of shame. In idiots or imbeciles this feeling may be entirely absent and incapable of cultivation, so that, sooner or later, the condition known as moral insanity is developed. In acute attacks of mental disorder there may be complete absence of shame or self-reproach; the unconventional, both in language and conduct, manifests itself as a symptom of the disease. In melancholiacs these feelings are usually morbidly active, and self-condemnation is rather the rule than the exception. Introspection, or rise in the subject-consciousness, is a prominent factor in the production of a painful conscience. To "know thyself," is to suffer shame and endless reproach. In asylums those individuals who have a tender conscience often know themselves better than do the sane. It must not be forgotten, however, that a morbid introspection may be productive of false accusations and needless remorse.

The lower *æsthetic feelings* connected with the appearance of the body, may be considerably perverted in the insane. In states of melancholia, mania, or dementia, there may be absence of all personal cleanliness and care; or, as in general paralytics, exalted maniacs, and monomaniacs, there may be exaggeration of the lower æsthetic feelings, ranging in degree from extreme care and eccentricity, to decorativeness and dandyism. In the eyes of some maniacs and general paralytics every object assumes the charm of beauty; while the persecuted and melancholiac may view everything as ugly or loathsome.

The *intellectual feelings* derived from the acquisition of knowledge, are familiar to most of us. This tone of feeling once developed is associated, during its temporary absence, with an intensification of the pain of idleness. On the other hand, so great may be the desire for knowledge, and so intemperate the methods of acquiring it, that the emotional tone may be exhausted and distaste result. In the insane, the engagement of the emotions in some other direction acts as a deterrent from any intellectual activity. Hence it is, that those who are morbidly introspective, or hyperattentive to their dominant ideas, are necessarily unable to apply themselves to any consideration requiring intellectual effort.

The *rational feelings*—those feelings associated with truth, morals, and religion—are sometimes absent, exaggerated, or perverted in the insane. Until Prichard described affections of the moral powers as occurring without obvious impairment of the intellect, it was doubted whether there was such a condition as moral insanity. Hack Tuke succeeded in convincing us that *moral insanity*, without any obvious intellectual impairment, does exist in certain individuals. Moral deficiencies or perversions may be determined (1) primarily by internal factors through inheritance. Some children inherit dispositions in which the moral sense is incapable of development; others betray the existence of an immoral tendency during childhood, and, in spite of training, remain incorrigible. (2) Moral perversions may be evolved gradually; they may be the outcome of special social influences, or the result of some slight cerebral disturbance or disease. Hack Tuke demonstrated that it may be practically impossible to detect the intellectual flaw, and yet a physician may be driven to decide that a person is insane. (3) Moral insanity may show itself as a precursor of other forms of insanity. Thus, it may precede delusional states; it may occur as an early sign of general paralysis or senile insanity; it may also show itself as an early symptom of an acute maniacal attack. (4) Moral insanity may exist as a sequel to a cerebral attack. Thus, cases have been observed where moral defect has remained as a sequel to sunstroke, febrile delirium, cerebral syphilis, and acute mania. (5) Moral insanity may exist as an associative phenomenon with brain disease, or with other diseases which affect the brain and its membranes. (6) Other causes, such as alcohol, masturbation, amenorrhœa, parturition, lactation, etc., may determine a loss or perversion of the moral sense, without obvious change in the intellect. (7) In an unstable nervous system a moral or physical shock may determine a moral disorder. (8) In epileptic states the moral nature may be affected without affections of the memory or intellect. Clinically, we have to note the following forms of moral insanity: (1) In children there may be absence or precocity of the moral feelings. Such conditions may be manifested by affections of the sexual instincts, homicidal tendencies, wanton cruelty, lying, stealing, masturbation, and pyromanias, etc. (2) In adults, we have to note, the morbid cravings for intoxicants, homicidal and suicidal tendencies, pyromanias, kleptomanias, the conditions of moral languor, the morbid religious emotions, and moral dislikes and prejudices.

Hack Tuke held, that the theory of the existence of moral insanity, apart from intellectual impairment, is in full accord with the principles of mental evolution and dissolution as laid down by Herbert Spencer. After a careful consideration of the psychological and clinical facts he made the following propositions :—

"(1) The higher levels of cerebral development which are concerned in the exercise of moral control—*i.e.*, 'the most voluntary' of Hughlings-Jackson, and also 'the altruistic sentiments' of Spencer—are either imperfectly evolved from birth, or, having been evolved, have become diseased, and more or less functionless, although the intellectual functions (some of which may be supposed to lie much on the same level) are not seriously affected; the result being that the patient's mind presents the lower level of evolution, in which the emotional and automatic have fuller play than is normal.

"(2) No doubt it is difficult to lay down rules by which to differentiate moral insanity from moral depravity. Each case must be decided in relation to the individual himself, his antecedents, education, surroundings, and social status, the nature of certain acts, and the mode in which they are performed, along with other circumstances, fairly raising the suspicion that they are not under his control."*

In concluding this chapter we may mention that, disorders of feeling may occur at all or any periods of life. In childhood or at puberty, the usual emotional accompaniments of the physical or mental evolution may be absent, perverted, or morbidly intensified. During the periods of adolescence, climacterium, prime, or senescence, emotional instability may manifest itself. In the female the emotions are liable to be upset during pregnancy, parturition, and lactation. Idiots and imbeciles display every kind of emotional disposition. Some are good-tempered and happy, others are irritable and morose. Undoubtedly, many of the criminals in our jails are of the imbecile class, and, in the commission of their crimes, they have been more or less unconscious agents. Ireland says, that idiots and imbeciles seem to be much more expert at taking up moral relations than one would suppose from their

* *Vide* "Tuke's Dict.," p. 813.

other deficiencies. "They attach praise and blame to particular people and to particular actions. They are accessible to pity, and still more to affection. The better classes of imbeciles can often be induced to make considerable sacrifices for the happiness of others, giving away, for example, things which they like, and preferring the pleasure of seeing others enjoy them. . . . The lower class of idiots have no religion. Imbeciles can be taught the existence of a Superior Being, though their ideas thereupon are childish, and have a tendency to become anthropomorphic. Some imbeciles take up the notion of responsibility to a higher power, which distinguishes the religious man from the simply moral. They can learn the biographical and historical parts of Scripture, the precepts in the Gospels, and the parables; but it is vain to try to teach them doctrines such as those contained in the Shorter Catechism or Thirty-nine Articles, which they neither can remember nor comprehend." Idiots of the Mongolian or Kalmuc type are usually affectionate and cheerful. They are good mimics, and fond of music. Seguin and others suggest that these types are connected with some form of hereditary cretinism. In sporadic cretinism characterised by the presence of fatty tumours in the posterior triangles of the neck, and in many instances absence of the thyroid gland, there is usually a good temper; but the higher emotions are little developed. In endemic cretinism the emotions or tones of feeling may be entirely absent; or, in the higher grade (semi-cretinism), there may be an emotional accompaniment to the vegetative or animal instincts, or to the impressions of the special senses. In the still higher grade (*crétineux*), the exercise of the intellectual faculties may be attended by a corresponding emotional tone.

Just as there is no constant relation between the degree of intelligence and the weight of the brain, so there is no relation between the feelings and the size of the head. It is not uncommon to meet with microcephalic, hydrocephalic, or scaphocephalic idiots, or idiots with cerebral hypertrophy, who possess emotional characters differing little from ordinary human beings. Sometimes they enjoy a joke, sympathise, and form affections out of all proportion to the amount of their intellectual development. Cases have been recorded in which all the special senses in the microcephalic idiot have been developed to an exquisite degree, and, with the development, also a corresponding tone of feeling. Some idiots, like some sane people, have little intellectual power, but acquire a religion through imitation and habit.

In hereditary epilepsy the epileptic attack is often preceded by irritability or by an emotional outburst. Sometimes the fits are followed by a tendency to cruelty, pyromania, etc. Meschede* has described such a case due, according to him, to an osseous growth upon the clivus, with consequent inflammatory affection of the adjacent membranes and nervous tissue.

The period of puberty is attended with marked physiological and psychological changes. Associated with the development of the genital organs, there are awakened the sexual instincts and all their corresponding emotions. In the female, we have to note the occurrence of hysterical attacks, and those mental manifestations of the development of the sexual organs. In the male, on the other hand, the emotions undergo little change at this period. At the period of adolescence, however, he undergoes a mental evolution, with which there is developed an egotism that sometimes passes the border line of sanity. The psychology of puberty and adolescence forms an important study, and one that ought to commend itself to all of us. We do not understand the physiological side of the special evolution of the emotions at this period, nor are we aware that any attempt has been made to analyse it.

For an account of the various disorders of feeling occurring at the different periods of life, the student is referred to text-books on insanity. It only remains for us now to state, that emotional perversions may be symptomatic of such states as mania, melancholia, or even of mental enfeeblement. The emotional disturbance itself may or may not be the only indication of unsoundness of the mind. Absence, exaltation, or perversions of the emotions may be symptomatic of degenerative states, such as general paralysis, paralytic or senile dementia, or epilepsy and its allied states.

* "Zeitschrift für Psychiatrie," xxix. Band. 1 Heft.

CHAPTER XIII.

The Will.

Definition — Deliberation — Choice — Resolution—Self-determination—Delayed Reflex—Influence of Habit—Desire—Psycho-Physical Processes of Volition — Volition not to be explained Anatomically, Physiologically, Developmentally, or Pathologically — Reflex Acts—Periphero-Motor—Centro-Motor—Automatic Acts —Voluntary Acts—Motor Images—The Will Power in Hypnosis —The Feeling of Effort—Introspective Evidences—Physiological Inhibition — Nervous Resistance — Movements — Central—Peripheral — Simultaneous — Sequential — Speech Movements—Disorders of the Kinæsthetic Word Apparatus—Deaf Mutism—Acquired Defects of Speech — Alliteration — Verbigeration — Akataphasia—Speech Defects in the Insane—In Sleep and its Associated Conditions—Conduct—Nervous Mechanism of Conduct—Conclusions as to the Existence of a Will—Impairment of Will Power — Irresolution — Defective Impulsion — Excess of Impulsion—Defective Voluntary Attention—Absence of Will—Conclusions.

THE WILL.

To those active operations of the mind which involve movements and active concentration of the attention upon an object or idea, with the addition of a resolve, the term "will" is applied. Such voluntary operations involve a purpose, and the movements are consciously directed towards some end. Volition is sometimes regarded as only a more energetic form of desire, inasmuch as it engages the muscular system as well as the motor centres. Expressed psychologically, volition is the revival or representation of former presentations which have been accompanied by feeling; the representation, if painful, is avoided; if pleasurable, favoured. Coupland describes will as the act of striving to procure a pleasure or to suppress a pain. The same author regards the term "deliberation," if taken too literally, as misleading, because it is apt to suggest that the human subject of the representations is passively affected, whereas, the experience and organised nature of the subject are themselves all-important factors in the case.

The human being possesses an organised nature which responds to its environmental influences. The nature of that organism, and the nature of that environment, determine the characters of the representations. Under the competing influences of such representations, action may be delayed until one representation gains the ascendency. The action which follows upon this delay is termed "*voluntary*," the delay is "*deliberation*," whilst the term "*choice*" symbolises the comparing of ends, and "*resolution*," the ascendency of one end or motive over the others. When we trace the origin of the phenomena included under will, we find that there is no hard and fast line of demarcation between the so-called "appetitive action," and the highest forms of purposive action or self-control, which manifest themselves as voluntary only, after passing through the stages of deliberation, choice, and resolution. Before discussing the questions of the sense of effort, and the adjustments of the motor apparatus involved in the active operations of the will, it is essential that we should know something about the speculations which have been made as to the existence of a free will.

Since Plato made the distinction between voluntary and involuntary mental activities, the discussion as to whether the will is self-determined, or whether it is necessitated, has engaged the attention of every psychologist and moral philosopher. The older writers, such as Plato, Aristotle, the Stoics and Epicureans, however, did not discuss the problem of freedom in the same way as did the Neo-Platonists, and the Christian apologists of the second century. The latter writers supported the view, that freedom consisted in independence from external causes. The mind itself was regarded as possessing perfect freedom of choice between good and evil. Some idea of the theological aspects of the question may be gathered from the writings of St. Augustine, Aquinas, Calvin, Pelagius, Arminius, and others; while the philosophical relations have been treated by Hobbes, Descartes, Locke, Leibnitz, Clarke, Edwards, Priestley, Reid, Hamilton, Stewart, Mill, and others. The doctrine which implies that the *ego* is in itself an active principle, is one which we are compelled to leave to philosophy or metaphysics. We have not the means of testing power or final causality; we can only base our views upon the observable phenomena or facts of volition within ourselves or others. The ethical side of the doctrine is of course of immense importance, inasmuch as it obviously influences the theory of moral responsibility.

The modern tendency is to regard the will, or rather the active expression of the will, as a *delayed reflex*. The delay is brought about by the co-operation of reflection, which serves to modify and protract the ultimate resolution upon which the appropriate action depends. This ultimate resolution is regarded as dependent upon some impulse or idea bearing a relatively greater degree of intensity than the other factors deliberated upon. Volkmann* regards the power which reveals itself in the final volition as being no power above the representations, but only a new revelation of the powers working in the representations, and he believes that the final volition gives the advantages to one of the contending volitions, or perhaps suspends both. This he explains by the fact, that this very volition proves itself ultimately to be the resultant of the collective internal movement. Sully adopts a somewhat similar view, and believes that in every case the action is the resultant of the factors ultimately engaged.

Later, we shall see that the characteristic *manifestations* of "will" are to be explained as the results of habits organised in the individual, and transmitted to the progeny, either as a tendency to react readily, or as a tendency to deliberate before acting. In any case, the psychical and physical factors acting at the time determine the individual or particular reaction characterised as the effort of will. It is unnecessary to point out that all active operations of the mind involve an intellectual and emotional element, and that just as there is an opposition or furtherance of the states of knowing and feeling, by reason

* "Lehrbuch der Psychologie," vol. ii. p. 456.

of their mutual relations, so there may be a mutual furtherance or hindrance of activities of the will by reason of its relation to the states of knowing and feeling. As Sully puts it, "The outgoings of the mind in action, involving the excitation or 'innervation' of the motor nerves and muscles, are incompatible with the comparatively passive state of observing something or thinking about something, with its physical accompaniment of bodily stillness. The man of energetic action is popularly contrasted with the man of reflection. Similarly, strong emotional excitement and action are incompatible, and the man of strong will is one who, among other things, brings emotion under control."

A full account of the nature of willing would include (1) the primary presentation with its accompanying tone of feeling; (2) the representative process, with the realisation that the revived process forms a step in the experience of the *ego;* (3) the struggle for existence among the representations when reviewed by the *ego;* (4) the deliberation upon the qualitative aspects of the representations; (5) the conscious choice of a desired representation; (6) the belief in the fitness of the action to acquire the desired end; (7) the resolution to acquire the desired end; and, lastly, (8) the revival of the appropriate image, and the action which is believed to lead to the desired end.

With the growth of experience, the instinctive impulse of the child to avoid pain involves more and more of the representative element, until the consciousness of recoiling from what is painful becomes a desire to avoid it in the future. Thus, desire becomes an essential element in all voluntary action. Without the representative element, there is little or no desire. In addition, the representative element must be accompanied by a revival of the primary tone of feeling, otherwise, desire disappears. When the revived tone of feeling is morbidly intense, or when it is inferior to the primary tone, there may be a feeling of craving for the actual realisation.

The absence, exaggeration, or perversion of the representative elements of desire may be the primary factors in the development of the morbid apathies, and the excessive or abnormal volitional activities of the insane. Similarly, failure in the revival of the tone of feeling that accompanied the primary presentation, may result in an apathy and absence of desire. The melancholiac or the maniac may be unable to recall the feelings of love for home and its surroundings, and apathy or indifference results. There is no desire to recover or to return to their homes. The alcoholic dement may be deficient in desire, and consequently in volitional activity, by reason of his defective memory. Similarly, in dotage the characteristic amnesia may account for the failure of desire.

When we desire a thing we are apt to concentrate our attention upon it, so that its representation assumes the character of a dominant idea. This concentration of the attention involves a certain amount of effort, which may become active tension or strain if the desired end is not realised. In this way we see how the motor or bodily element comes into play, either as a distinct voluntary or anticipatory adjustment, or as an imaginary representation of bodily movement. The degrees of intensity of desires, and the range of movements prompted by them, as manifested in the insane, form a subject so extensive that we cannot enter upon it here. It must suffice to know, that just as sane individuals are indolent or active according to their moods or temperaments, so the insane present every degree of activity from apathy and anergia to active impulse and maniacal violence.

When we survey the endless controversies of the evolutionists, both biological and dialectic, which have for their object the identification of desire and will, we fail to understand from the analogies of lower life how the will, the volition, the conscious guidance, or call it what you will, comes into existence at all as a factor of mental life. Here we must confess that the intelligent activities of ethical life do appear to indicate the existence of a rational principle. The ultimate *locus standi* of the moral intuition is, however, beyond the grasp of science.

Whether we regard the will as a separate faculty or a part of the mind as a whole, we must be struck with the fact, that neither intellect nor emotion can direct itself or govern the mental life of the individual without the aid of the intelligent self-determinating influence denominated will. We do not hold with Kant's transcendental theory of the cognition of moral law, that the will stands as a faculty of determining oneself to action in accordance with the conception of certain laws, and that such a faculty can be found *only* in rational beings.* It is well nigh impossible to mark the point of transition from animal life to the so-called rational life. In other words, we do not know where thought-determined activity comes in in the animal series. The transition between impulsive and reflective activities is to be as readily traced as the transition between primary sensations and representations. An adequate philosophy must posit the reflective activities as the outcome of the impulsive at the very beginning of sentient existence. Those activities which go to constitute action, and are uniformly present in conduct, are not the exclusive property of mankind.

When we try to account for the origin of the modification of consciousness, known as deliberate purpose, and confine its existence to man, we render ourselves open to a discussion upon the main problem of animal life and conduct, and, at any rate from the empirical point of view, we have to begin at the very beginning. Whether the soul possesses an independent energy, which makes the individual the source of activity, and, therefore, reasonably and justly responsible for his conduct, is a matter of individual opinion. The materialist scoffs at such an idea as absurd. He sees the mind as the outcome of molecular activity. The spiritualist, on the other hand, views the mind as independent, or as being but a lesser manifestation of an all-pervading archetypal essence of true morality or rationality of action. The former pictures the mind as a result of infinitesimally minute atomic movements. The latter pictures an all-pervading mind as the guiding power of an infinite cosmical activity. In both, hypotheses are scientifically of no avail. The ultimate nature of both series of events is transcendental to all the powers of human inquiry. We, as passive onlookers, view the empirical sides of the question, and can conceive, that if the infinitesimally minute atomic movements within lumbar ganglion cells can serve a higher centre with an activity which ultimately becomes symbolised as moral law, then so also can the infinite cosmical movements serve a universal mind. When we look through a microscope at a

* Kant, "Metaph. of Ethics," chap. ii.

minute nervous structure, we see the structure and imagine the movements of atoms which would correspond to mind. When we gaze at the vault of the heavens through a telescope, we see the innumerable worlds, and imagine a sensory and motor intelligence, which would correspond to the Deity. If movement is all-sufficient in the one instance, then why not in the other? We know nothing about a higher mind, it is true. But it is readily conceivable, that just as the atoms of a lumbar molecule may serve and obey a mind, of which they know nothing, so we, as atoms on this earth molecule, may serve and obey a mind, of which we also know nothing. When the student has once grasped the meaning of the mind and body, and has satisfied himself as to how much he really knows, and when he has reflected upon the nature and extent of the cosmos, he need never be accused of favouring the propagation of scientific dogmatism with regard to the Unknowable.*

Some authors, and more especially those of the modern German school of thought, are satisfied that they can deduce action from presentations, representations, and the laws of association. They ignore the assumption that there is an especial will as the cause of our actions. According to Ziehen, "When we *will* do something, our own psychical content at that moment is only distinguished from other psychical contents by the fact, that the idea of a desired action, accompanied by a positive emotional tone, is already contained among the sensations and ideas that are then actually present." The same author gives the following order of events as occurring, when we say, "*I will do something.*" The sentence, when spoken, is "a series of motor ideas of speech with which are associated (1) the *ego*-idea in the sense formerly discussed; (2) the idea of a future act, accompanied by a positive emotional tone; (3) motor sensations accompanying attention; and (4) the idea of a causal relation existing between the *ego*-idea and the desired action." Ziehen also makes the positive assertion, that the attempt to set up special diseases of the will under the name of monomania, or a general disease of the will designated as moral insanity, have all been recognised failures. He seeks to reduce all disturbances of voluntary action met with in

* The consideration of the Dogmata of Faith is quite another matter.

insanity, to disturbances of the sentient life, especially of the emotional tone, or to intellectual disturbances—*i.e.*, disturbances of the ideas or of the association of ideas. We quite agree with him, that the loss of will-power may always be reduced either to the exceeding sluggishness of the association of ideas, to the abnormal negative tones of feeling, or to other similar afflictions; but we utterly fail to follow the reasoning which seeks to prove that because one phenomenon can be demonstrated as dependent upon another phenomenon, therefore the one phenomenon is that other phenomenon. Were we to adopt his method of argument, we should be compelled to deny the assumption of a special faculty of the emotions, because that faculty is dependent upon cognitive states, and can be reduced to the terms of such states. Because one state can be demonstrated as the obvious outcome of another state is no reason why the two states should be held as identical. The phenomenon of the will is psychologically as distinct from the intellectual and emotional faculties (although dependent upon them) as a new-born child is physiologically distinct from its mother (although dependent upon her for its origin). Were our task of analysing the nature of the will completed by the description of the intellectual states and their emotional accompaniments, we would consider ourselves as mere automata responding to a force over which we have no control. The direction of our efforts would be turned like a weathercock, with every stimulus. *It is just the conscious selection of the most appropriate reaction to circumstances, and the voluntary activity thereby involved, that constitutes what is known as the will.*

It is significant that the most strenuous opponents of the theory of the will faculty are foremost in drawing a line of distinction between reflex and voluntary acts. Ziehen himself regards the reflex and automatic acts as the physiological, and the ideational acts as the psychological, antecedents of voluntary acts. Here again, we may repeat, that, although a condition can be resolved into terms of its antecedents, there is no proof that the condition itself is not present, but only the antecedents. Were such arguments possible with physiological or pathological problems, we should find ourselves involved in a disquisition upon the absolute inseparability of cause and effect. In the meantime we have to recognise that the terms, "voluntary," "conscious guidance," "will," etc., can never be replaced by terms of intellection or emotion.

Let us now analyse the **Psycho-Physical Processes of Volition.**—When we trace the evolution of the early movements of an infant to those higher movements termed voluntary, we find that there are involved two sensorial elements —viz., the impressions derived from the special channels of perception, and the impressions derived from the movements (sense of effort, kinæsthetic auxiliary). Andriezen* regards the mode of evolution of each special or local sense as having been a twin evolution, a special kinæsthetic element having entered into it, and got incorporated with it.

"During the condition of attention," says Andriezen, "there is not only an increased functional activity in this or that sensory centre, but an overflow or discharge from that centre to *others* along definite routes, or diffusely all over its borders. Where a voluntary act or movement is one of the outcomes, the neural discharges consist of (*a*) primary sensation, focussing-reflex, attention; and (*b*) discharge from such sensory centre, (*c*) with resultant excitation of other sensory or psychical centres, arousing feelings and mental images (ideas), or of a kinæsthetic centre, in the last case evoking a more or less obviously special movement. The sequence of events comprises, therefore, (*a*) arousing a sensory centre to attention; and its discharge, along (*b*) a tract to (*c*) a kinæsthetic centre; followed by an appropriate movement to its completion, or, in psychological language, *first*, perception; *second*, apperception and attention; *third*, strong revival in mind of the act to be performed; *fourth*, execution of the idea. Attention thus belongs to the sensory side; volition to a specialized and intensive discharge therefrom to the kinæsthetic sphere. Volition is thus a development from attention, and passes on to execution; it is thus the passing from *attention* to *execution*: in the brain it overlaps the psycho-motor sphere on the one side, and the sensory on the other; its region is, therefore, the *transitional* or association system one between these two. On the anatomic-physiological side we think the mixed pyramidal or polymorphic system to chiefly represent this association region, partly on comparative and developmental grounds, and partly from pathological considerations. The gradual historical development and elaboration of this system in the mammal till it attains its acme in man, and the lateness of this lower cortical organisation to complete its growth in the new-born and young, indicate that this 'accessory

* "Brain," 1894, p. 676.

association system' of the brain is the chief structure which subserves the higher psychical functions, and especially volition. Further, of all the various cell systems involved in chronic alcoholism, it is the one in which the changes, especially the trophic ones, are most advanced."

In the main, we are in accord with these views, so far as they go; but, as we have seen in preceding chapters, we know nothing about the perceptive side of sensory impressions so far as their ultimate localisation is concerned; nor do we know the regions concerned with the immediate transition of mental to motor events. If we assume, that within the higher psychical regions—the ultimate substratum of consciousness—the sensory elements are distinct from the motor, then we are justified in imagining an association scheme between the two. We are not aware, however, of any comparative, developmental, or pathological facts which would lead us to decide upon this question. The arguments advanced to prove that the "accessory association system" of the brain is the chief structure which subserves the higher psychical functions, and especially volition, may be valid as far as they go, but they give us no light upon the actual *serving* of the psychical functions. The student is urged to reflect upon the question as to how far we have got in our efforts to trace a sensory stimulus to its terminal point in the cortex; then, if he can, to satisfy himself as to the *fons et origo* of a highly developed motor impulse. When he has grasped the fact, that his knowledge about both series of events is inadequate, then he will be in a position to estimate the value of the various hypotheses hitherto advanced.

Volition cannot be explained anatomically, physiologically, developmentally, or pathologically. The existence of voluntary activity, as viewed objectively and expressed psychologically, is as clearly manifested (in its rudimentary form) in the protozoon as in man. Certainly, the gradual historical development and elaboration of the nervous system has been coincidental with the empirical evolution of the normal will manifestations. But the actual conditions of reaction or initiatory transformations—to say nothing of many pathological affections of the will hitherto inexplicable by natural law—are, and doubtless will be, unknown to us.

In an early chapter we briefly mentioned some of the differences between reflex and automatic acts. We propose now to study the progressive development of these acts, and to trace them to the so-called conscious or voluntary acts.

We are all acquainted with examples of conscious acts becoming automatic through repetition. The psychical accompaniment becomes gradually less and less with each repetition, until finally there is no obvious psychical correlate, or the mind may be engaged in other directions. Ziehen divides automatic acts into two large groups, according to their development: (1) Those which have developed from reflex acts in the course of long ages and many generations—*i.e.*, phylogenetically; (2) those which are the product of voluntary acts during the life of a single individual—*i.e.*, that have developed ontogenetically. Meynert attempts to prove that voluntary acts are derived from automatic. Münsterberg, on the other hand, tries to prove that automatic acts are derived from acts of the will. Automatic acts are more complicated, and present greater variability than reflex acts. In neither are there any psychical concomitants. An automatic act also resembles an instinctive act in this latter respect. On account of the great diversity of automatic acts, it is sometimes difficult to distinguish them from conscious or voluntary acts. Inasmuch as reflex and automatic acts do not involve a psychical correlate, their consideration falls more particularly to the physiologist. Physiologists have sought a mechanical cause for the various activities of life, and they have, to a certain extent, succeeded in enumerating many of the phenomena displayed; but, directly the question of a psychical correlate appears, all is confusion.

Let us now look more closely at those forms of activity known as (1) "reflex," (2) "automatic," and (3) "voluntary," and from a study of the two former modes let us see what we are entitled to conclude in regard to the third.

Reflex acts have no psychical accompaniment, they are initiated by means of external stimuli, and the motion is fairly constant. The term "excito-motor" has been applied to them. Such reflexes include the ordinary physiological reflexes of organic life. Some authors describe under reflex actions all the active states which are the involuntary results of psychical states. Harris* has attempted to classify reflex actions on a psycho-physiological basis, as follows :–

I. *Periphero-motor*—
1. Excito-motor.
2. Algio-motor.
3. Sensori-motor.

II. *Centro-motor*—
1. Emotio-motor.
2. Ideo-motor.

In this scheme the various groups of reflex actions are arranged in ascending degrees of psychological complexity. The scheme in its entirety would correspond to the sum total of the involuntary actions of life, and were we unable to exercise the prerogatives of a will, our lives would be, and possibly might be explained as, mere reflex mechanisms, with a superimposed ideational state which becomes aware of what has happened to us and how we have reacted upon it.

Without the element of the will we fail to differentiate between actions which are involuntary and those which are voluntary. In our acceptation of the term "reflex," it is unnecessary to widen its meaning to include the various psychical elements of action; otherwise we should be compelled to return to the metaphysical question as to how far all mental activity is reflex.

Automatic acts have been described as evidences of mental automatism. The actions are generally appropriate, modified by some intercurrent cerebral influence, and have no equivalent in consciousness.

Hack Tuke defines mental automatism as "a state in which a series of actions are performed without cerebral action or conscious will, as during reverie, or in certain morbid conditions." † We do not regard this definition as satisfactory, inasmuch as we look upon the phenomena as being essentially forms of cerebral action. It is impossible to conceive the occurrence of many of the higher forms of automatism as being other than the expression of the automatic action of the cerebrum. Carpenter says, "Looking at all those automatic operations by which results are evolved without any intentional directions of the mind to them, in the light of reflex action of

* "Brain," 1894, p. 232. † "Tuke's Dictionary," p. 115.

the cerebrum, there is no more difficulty of comprehending that such reflex actions may proceed without our knowledge, so as to evolve *intellectual products*, when their results are transmitted to the sensorium, and are thus impressed on our consciousness, than there is in understanding that impressions may excite muscular movements through the reflex power of the spinal cord, without the necessary intervention of sensation." * We find great difficulty in satisfying ourselves upon this point. According to the theories of the day, psychical states are the concomitants of various physiological activities within the cerebrum. With the higher automatic acts we are forced to assume that these physiological activities occupy within the cerebrum the so-called sensory or motor areas; in fact, the same nervous elements as are involved in ordinary conscious reactions. Therefore, unless we hold that the mind depends upon activities occurring at some other site or level, we must grant that the mere physiological activity of the strata which *subserve* consciousness—the so-called sensory and motor areas—are capable of determining a psychical correlate in some instances, and not in others. For the present we can offer no solution of this question. It is difficult to understand how apparently identical physiological processes may occur with such widely different psychical correlates.

Voluntary acts have conscious correlates. The nature of the psychical elements involved in voluntary action we have already in part considered: it will be necessary, however, to devote some attention to the so-called "ideas of motion" which precede the actual motion, and to the so-called "kinæsthetic sensation," or "sense of effort," which follows the motion. Ziehen believes, that between an idea of the motor act to be performed and the sensation derived from the performance of the act, there is no other psychical element introduced. He reduces the psychical elements of voluntary action to ideas and sensations. He does not believe that a third psychical factor exists, unless the association of sensations and ideas be considered as such. In his efforts to prove that no other psychical element is introduced, he shifts the whole responsibility of the action upon ideation, and thereby makes the individual an

* "Mental Physiology," p. 607.

ideo-motor reflex mechanism. He fails to account for the conscious selection of one out of a series of ideo-motor reactions. We hold, therefore, that in the play of motives (the review of ideo-motor activities—deliberation) a choice is made by the mind as to which action is most appropriate, and with this is involved the recognition that the *ego* is free to judge the merits of the ideas. With the selection of the most appropriate idea, the necessary activity is called forth. Moreover, *it is just this conscious selection of activity, and the relation of its interpretation to the ego, that determines the difference between the higher forms of automatism and voluntary activity.*

Ziehen believes, that the feeling that we exercise a free choice in the association of ideas and in action is easily explained by the fact that, in distinction from automatic acts, association and action are not only determined by external stimuli, but are also influenced by ideas, the sum total of which we may designate as our empirical "*Ego.*" "We believe that we exercise a free choice," says Ziehen, "because (1) we ourselves are conscious participants in the active association of ideas; and (2) although the result of this association, or, in other words, the result of the play of motives, is not distinctly foreseen, it is nevertheless anticipated; (3) because the decision is also finally made by a part of the *ego*—*i.e.*, the prevailing ideas." This assumption, that the ideas themselves make the final decision, is incomprehensible. We can as readily conceive a series of examination papers settling among themselves the question as to which should take the prize, without the decision of the examiner, as we could conceive a series of ideas determining among themselves as to which might be the most fit to represent the organism, without reference to the *ego* itself. If we grant that an idea alone can determine an activity, then we must also grant that an idea can actively compare itself with other ideas. Similarly, when a fallacious conclusion is brought into consciousness side by side with a conclusion that is valid, the fallacious does not itself bow and retire on account of the merits of the valid. The decision is made by the *ego* itself; the logical train of thought whereby that decision is arrived at is merely the instrumental means at the disposal of the individuality which reflects and judges. Hence we take it that the arguments hitherto adduced against the existence of a will are invalid. The conception that the last witness in a trial determines the decision, and that the witness is, in fact, the judge himself can scarcely commend itself to anyone; and yet this is the argument pushed forward by one of the most strenuous advocates of the non-existence of the will.

Let us now consider more particularly those motor images, or ideas of movement that immediately precede the actual performance of a movement. A primary act is reflex or involuntary, and the revival in memory of the image of the act may result in its repetition, also involuntarily. When, however, an image of movement is deliberated upon, desired, resolved, and willed, then the realisation of the act is voluntary. Some individuals—persons who possess a weak will—are subject to uncontrollable or involuntary reactions, due to the intensity or nature of the revived image. James says the first point to understand in the psychology of volition is, that "voluntary movements must be secondary, not primary, functions of our organism." He regards reflex, instinctive, and emotional movements as being primary performances. It is difficult to clearly define the transition between so-called primary performances and those which are secondary. In some of the emotional movements, for instance, we are often unable to decide that there has been no revival of a former experience. In fact, we are inclined to lay more stress upon the factor of conscious deliberation and selection, than upon the mere question of the secondary nature of the movement. Undoubtedly, ideas of movement are pre-requisites of voluntary action; but were the elements of memory entirely eliminated from an emotional movement, that movement would be wanting in its characteristic features and expression. We have only to observe the absence of emotional movements in some amnesic patients to satisfy ourselves that the memory is almost as important in the higher involuntary as in the truly voluntary or deliberative series of events. In both instances, guiding sensations are absolutely essential for the successful performance of the series of acts. The pianist who performs automatically depends upon guiding sensations as much as the one who concentrates his attention upon his kinæsthetic impressions.

In the state of artificially induced hypnosis, the will power is sometimes retained intact. Bramwell has demonstrated that although there is an extreme readiness to react to suggestion from without, yet there still remains a higher controlling influence, or auto-suggestion, which enables the hypnotised person to deliberate, choose, and inhibit at will.

During the waking-state of one of Dr. Bramwell's patients we made the suggestion to her that she ought to resist a certain movement during her hypnotised state. Dr. Bramwell was not present at the time that the suggestion was made, and was quite unaware of the restriction imposed upon the patient. On testing the movements suggested during the hypnotic state, he found that the patient absolutely refused to carry out his suggestion with regard to this particular movement. The auto-suggestion proved as efficacious during the artificial state as during the normal state. How we are to explain this retention of the individuality of the subject we do not know. The facts alone would appear to warrant the conclusion that the memory image of the special act to be restrained was present during the artificial state, and that there existed a certain degree of continuity between the primary mental conception and the secondary inhibition. On again awaking this patient remembered our suggestion, but had not the faintest recollection as to what had happened during hypnosis.

This question becomes one of extreme importance from a medico-legal point of view. Dr. Bramwell believes that patients in the hypnotic state almost invariably refuse to perform acts which would be criminal or even indecent. Whether the refusal is only a manifestation of an *acquired* tendency to resist or to act in certain directions, or whether there is some mentalisation possible apart from true consciousness, we cannot attempt to decide. In the present instance the refusal to perform the movement (to make her arm stiff) was evidently the result of ante-hypnotic suggestion. We have yet to learn how far an individual is truly responsible for his actions during certain mental states; and, as the student may gather from such instances, the mere absence of memory of the events which have taken place during those states need not entirely negative the possibility of there having been some freedom of choice and the power of restraining certain actions.

The Feeling of Effort is of great psychological interest, and its relation to voluntary action has been the subject of a considerable amount of discussion. Müller * believed the nervous process to be purely central, and to consist in an efferent motor discharge. Bain, Wundt, and others adopt similar views. Most observers, however, believe that, apart from the psychical elements of deliberation, choice, resolution, etc., the feeling of effort is derived from the periphery by means of afferent sensory stimuli. From what we have already said about the feeling of effort in regard to the localisation of objects in space, the student will probably agree, that the theory of its central origin does not appear to be true. One fact in itself is significant, a person may retain his power of voluntary movement, but fails to obtain the feeling of effort when peripherally initiated stimuli are rendered impossible through paralysis of sensation, or after the amputation of a limb. Ludwig, Hughlings-Jackson, Crichton Browne, and others still uphold the "central" theory. Bastian, Ferrier, and others refer to the doctrine as disproved. Waller † made an objective study of the sense of effort, and supported the theory, that nerve, in so far as it is accessible to physical examination, is pre-eminently a passive and force-transmitting organ, and not an active force-producing organ. After excluding the nerve-fibre from consideration, he attempted to prove that the sense of effort is derived from sensations with action, whilst the sense of fatigue is also derived from sensations, but with *after* action. "The first is a sensation accompanying muscular action; the second is a sensation consequent upon muscular action. The first owes its being to molecular changes which accompany muscular action; the second to molecular changes which have accompanied muscular action—*i.e.*, they have a common cause, the changes which produce the first also produce the second, and it is not material to our argument whether the positive changes with the effect are succeeded by positive or by negative after-changes, as the substratum of the after-effect."

We cannot enter further into the physiological aspects of this question. What we have to decide is, Is there, in addi-

* "Psychologie d. Menschen," ii. p. 500.

† "Brain," 1891, p. 181.

tion to the images of passive sensation, a feeling of a particular kind associated with an outgoing current? Professor James has shown that the assumption of the feeling of innervation is unnecessary. To this view we conform, and we do not admit the necessity of an additional antecedent—the feeling of an efferent current—for the determination of a movement. The actual movement may be preceded by a state of consciousness made up of impressions derived from the periphery, or, possibly, reference may be made to impressions derived from a former completed circuit of afferent and efferent currents; but the mere fact of reference being made to the *results* of former outgoing currents, in no way implies, that before the present movement occurs there is a similar discharge in an outward direction.

Our experience is mainly derived from ingoing stimuli, and from the secondary ingoing stimuli, which are determined coincidently with the *effects* of outgoing stimuli. Therefore, we hold that, before the performance of a voluntary movement, there may be a revival in consciousness of the effects of former ingoing and outgoing currents; but that it is unwarrantable to assume, that with such a revival in consciousness, there is any actual revival of those physiological ingoing and outgoing currents themselves. The feeling of outgoing discharge is in reality nothing else than the feeling associated with the perception of the effects of an outgoing discharge—*i.e.*, kinæsthetic images may be the last psychic antecedents of actual movements, but those images need not necessarily be attended by actual outgoing currents. Why the feelings of innervation should be supposed to exist for movement alone, we do not know; were the theory plausible, we ought to be able to formulate some similar doctrine in the case of the other senses, and imagine, apart from adjustment, an outgoing current from the brain to the visual apparatus, preceding the voluntary perception of an object already within focus.

Professor James has pointed out in very clear terms, that we have no introspective evidence of the feeling of innervation. The only psychic state which introspection lets us discern as the forerunner of our voluntary acts is an anticipatory image of the sensorial consequences of a movement, *plus* (on certain occasions) the fiat that these consequences shall become actual.* Ferrier has demonstrated, that the consciousness of effort coincides with actual muscular movements present, and that no matter how much a person wills to perform a movement, unless there is some actual movement determined by an outgoing current, there can be no consciousness of effort. Münsterberg † has also denied the existence of such a thing as a sensation of volitional energy. He gives as reasons against the theory of the feeling of innervation: (1) Our ideas of movement are all *faint* ideas, resembling in this the copies of sensations in memory. Were they feelings of the outgoing discharge, they would be original states of consciousness, not copies, and ought by analogy to be *vivid*, like other original states. (2) Our unstriped muscles yield no feelings in contracting, nor can they be contracted at will, differing thus in *two* peculiarities from the voluntary muscles. What more natural than to suppose that the two peculiarities hang together, and that the reason why we cannot contract our intestines, for example, at will, is, because we have no memory-images of how their contraction feels? Were the supposed innervation-feeling always the "mental cue," we do not see why we might not have it even where, as here, the contractions themselves are unfelt, and why it might not bring the contractions about.‡ Having satisfied ourselves that *the feeling of effort or innervation is nothing more than the revival of the sensible effects of a former reaction, and that the revival anticipates a present movement*, we pass to the consideration of some of the active motions which seem to involve a special fiat of the will.

At the outset, we granted that feelings or ideas may precede actual movements, and that the existence of an idea may precipitate the movement; but we hesitated to adopt the view that all voluntary movement was simply ideo-motor—*i.e.*, involving no other psychical elements than ideas.

Professor James believes that the **inhibition** of a movement no more involves an express effort or command than its execution does. "A waking man's behaviour is at all times the resultant of two opposing neural forces. With unimaginable

* "Principles of Psychology," vol. ii. p. 501.

† "Die Willenshandlung" (1888), pp. 73, 82.

‡ Münsterberg, op. cit., pp. 87, 88 (quoted from James).

fineness some currents among the cells and fibres of his brain are playing on his motor nerves, whilst other currents, as unimaginably fine, are playing on the first currents, damming or helping them, altering their direction or their speed. The upshot of it all is, that whilst the currents must always end by being drained off through some *motor* nerves, they are drained off sometimes through one set, and sometimes through another, and sometimes they keep each other in equilibrium so long that a superficial observer may think they are not drained off at all." This hypothetical explanation of what takes place within the sensorium would be more readily conceivable were we able to eliminate the psychical element from our consideration. It is difficult to imagine a conflict between physiological currents, irrespective of their psychical correlates. We can speak of the conflict between motives, or incentives to act, from a psychical point of view; but we cannot grant that the act is determined entirely by the result of opposing influences in currents. The student must remember, that mental conflict is a fact of experience, and that the physiological equivalent is a mere conjecture which will not bear investigation. We are no more warranted in this case to suppose that the physical activities provide the full contents of conscious volition, than we were in the case of perception to suppose that the physical apparatus provided the mind with the ready-made percept. The conflicting currents—if currents there be—do not "fight it out" among themselves, and provide the *ego* with a ready-made fiat presentation—*i.e.*, we have no data to assume that the physical process accomplishes a definite activity without the correlation of just as definite a thought or mental process. When we attempt to explain the origin of these opposing currents, we are forced to take account of various psychical elements; and here, again, we become involved in difficulties, for we cannot assume that mind in itself possesses a material force.

Mercier concludes, that the action of nerve centres is arrested by a modification of the same process that sets the action going by the impact of an extraneous force. "The nerve-currents," says Mercier,* "are known to be undulatory in form, and the nullification of one set of waves by another similar set, is a

* "The Nervous System and the Mind," p. 74.

familiar occurrence in various regions of physics. The phenomena of the interference of waves of light and of sound, are cases in point. One set of sound-waves may so act on another set as to result in silence. . . . Hence, if a centre is put in action by one nerve-current, it is easy to conceive, nay, it is a necessary consequence of the constitution of nervous tissue as thus far expounded, that it should be liable to be put out of action by another nerve-current." The same author has sought to prove that every part of the nervous system is at all times the seat of continuously flowing currents of force. "Along every nerve-fibre gushes of force continually succeed one another, as waves of blood pass through the arteries. Every nerve-cell is, as it were, a heart, which receives the current flowing into it, and discharges it with increased impetus."* Mercier also states that, in order to start a nerve-centre into action, some force must impinge upon the centre from a source external to itself. "A centre at rest will continue at rest, and if in action, will continue to act in the same way, unless acted on by some extraneous force. Both to start the action, and to arrest it, some influence from outside the centre is necessary. The initiating impulse comes always, directly or indirectly, from the periphery of the body, and so from the outside world."

Let us now try to adapt a psychical process of inhibition to the imaginary physical counterpart, and let us, if possible, understand what happens. Firstly, we are to regard the nerve-cell as a pump somewhat similar to the heart, its functions being to receive and pump currents in this and that direction. Next, we are to regard its pump action as determined from the periphery. The "gushes of force" succeed each other regularly in the ordinary way—*i.e.*, when there is no particular form of movement to be performed. When, however, a special movement is to be performed, there is a special stimulus from the periphery, a special action of the nerve-cell, and a special direction of the current to the special motor apparatus; and, as the consequence of this peripherally initiated nerve-current, the movement is rendered effective. Inhibition is thought to arise in much the same way. A specially appointed and peripherally initiated current starts the activity of another nerve-pump, which directs an opposing current to impede the other, and

* Op. cit., p. 75.

thereby inhibit it. Mercier raises the hypothesis, that the extrinsic influence which tends to keep the nerve-cell from excessive activity is carried on by the motor centres concurrently with their more generally recognised function. Here, then, we have two sets of peripherally initiated currents—the active, and the inhibitory—acting in succession. The former leads off from periphery to pump, thence to motor apparatus; whilst the latter also leads off from periphery to pump, but overtakes the former, gets in front of it, as it were, turns it back, and thereby inhibits it. If the student can imagine one pulse-wave overtaking another and preventing its further flow, then he can also imagine the same with the nerve-currents. Inhibition is, psychologically and physiologically, a positive activity; and just as it is impossible to obliterate a recent thought by a present one, so it is impossible to interfere with one current by the passage of another. Each event is distinct and separate. With the assumption that there is a special inhibitory apparatus for the control of the force of the nerve-currents, we have nothing to do. We are prepared to admit that the nervous apparatus itself has a regulated tone. At the same time, however, we confess that we do not understand either the physiological nature of the tone or of the activities regulated by it.

The term "nervous resistance" is freely employed by some authors to indicate a hypothetical physiological state. Mercier says, "It seems reasonable to suppose that just as the physical process of the nervous discharge, when viewed in the aggregate as a physiological process, is the motor of muscular movement; so the nervous resistance when raised to the same power is the physiological factor inhibition." Let the student analyse the nature of events during an act of inhibition. In the first instance we must presuppose a tendency to act in a certain direction, and we may assume that there is a corresponding nervous activity; next there comes the inhibitory act with its nervous equivalent. We ask, In what way does the second activity differ from the first? In both series of events the activities are positive. I forcibly exaggerate my knee-jerk, or I inhibit it. Wherein is the difference? We can resist the *effects* of a just past nervous activity by the exertion of a present positive activity; but we cannot set up two currents in opposition to each other. When we look at an acutely maniacal patient we note his varied and often purposeless movements; and, moreover, such patients, on recovery, will sometimes say of themselves that they also had noted the motor excitement, but had insufficient power to control it. In such instances the nervous apparatus has been unduly active, and the individual has been deficient in the strength to control action. Mercier's conception that every nerve-centre is at all times subject to continuous control or inhibition, appears to be perfectly feasible, and we must accept the hypothesis that the nerve-centres are maintained in a condition of mobile equilibrium by the opposition of the inhibition exercised upon them, to their own inherent tendency to discharge, as manifestly true, inasmuch as it would be ridiculous to imagine any physical or systemic activities without such controlling influences.

We do not, however, go so far as to imagine that the state of inhibition is maintained by centres which exercise this function concurrently with others. The student must not confuse the notion of mere mechanical obstruction with that of so-called nervous resistance. The former may exist as a pathological factor of great significance in the causation of morbid mental states; whilst the latter may exist as a law of physics, of which, however, we do not as yet grasp the full psychological significance. To put the matter shortly, we may say, that (1) the regulation of the activities of the nervous system is determined by physiological laws, which, by analogy, appear to warrant an hypothesis about "discharge" and "resistance"; (2) when a psychical element is involved, the inhibition of one act is only possible by the positive exertion of another act which overcomes or negatives the *effects* of the first act; (3) the tendency to excessive activity of the nervous elements may be checked by the exertion of controlling nervous influences apart from any psychical influence, in which case the inhibitory influence may be termed physiological; but this physiological inhibition does not necessarily imply the existence of an opposing current which checks the positive current by an intra-tubular conflict; (4) the tendency to excessive activity of the nervous elements may, by the involving of psychic influences, be controlled by the positive exertion of other activities which overcome or render inert the effects of the excessive nervous activities. Thus, we are warranted in steering clear between the incomplete conceptions of physiological and psychological inhibition.

Movements.—Mercier has classified movements according to their character and to the parts of the body concerned with them. He clearly points out the difference between *central* and *peripheral* movements in regard to their precision, number and variety, generality and speciality, simplicity and complexity. Generally speaking, peripheral are more precise, more numerous, more varied, more special, and more complex than central movements. The co-ordination of movements may be *simultaneous* or *sequential*—*i.e.*, one movement may be combined with another movement simultaneously, or one movement may follow upon another movement as a sequence. "Those movements which are combined (co-ordinated) in simultaneity being mainly central, while those which are co-ordinated in succession are predominantly peripheral." The movements of the more central parts serve as a basis for many peripheral movements. The human body is capable of carrying on several series of central and peripheral movements at the same time. Thus, the organist may co-ordinate the movements of simultaneity and sequence of his legs, as in the act of pedalling; he may co-ordinate a similar series of movements of his arms in the act of fingering the key-boards and stops; he may also read the score before him, and co-ordinate the movements of speech and song; and moreover, in addition to all this complex activity, he may be conscious of totally irrelevant matters.

In the insane we see every variety of movement in simultaneity and succession. Thus some idiots and imbeciles constantly sway to and fro; others incessantly move their fingers or toes in a rhythmical manner. The *floccitatio* of the comatose, the rocking movements of the agitated melancholiac, the picking movements of the general paralytic, the constant restlessness of the maniac, the movements of the fingers in chorea, and the convulsions of the epileptic are all capable of classification. Space, however, will not permit us to consider all those variations of movements that depend primarily upon diseases of bones, ligaments, muscles, tendons, or upon affections of the motor nerves; nor can we discuss the influence of lesions of the sensory nerves, or the reflex mechanism of the spinal cord in the production of disorders of co-ordination. From a clinical point of view it is of interest to note, that cerebellar lesions determine movements which spread centrifugally, while cerebral lesions usually determine movements which extend from the periphery to the more central regions.

Before entering upon the question of abnormal conduct, and the habits and limits of self-control, it is necessary that we should devote some attention to the physiological processes connected with the production of speech. The motor processes, so far as they affect the larynx, pharynx, mouth, and nose, in the production of musical tones and noises, do not concern us. Presently we shall take some account of the pathological variations of the voice and speech; for the present we have only to do with the psychical and physical processes involved. We have already considered the question of the localisation of the centre for speech, and we have taken some account of the motor tract, and the effects of its lesions upon the mechanism of articulation, so that it is unnecessary to revert to them.

By far the most important mechanism of expression possessed by the human being is that of speech. By the movements of articulation we give expression not only to our sensations and special emotions, but also to ideas derived from memory and innumerable associations. When the region of Wernicke, in the auditory centre in the left temporo-sphenoidal lobe, is destroyed, words are still heard but not understood.* In studying the mode of expression in speech it is important to note the anatomical localisation of the tracts which have to do with expressive and imitative movements. Bechterew† and Ziehen‡ found that after the entire cortex of the cerebrum had been removed from a rabbit it still performed its characteristic

* Ziehen, op. cit., p. 260; Wernicke, "Der Aphasische Symptomen-complex," Breslau, 1874; and in Friedländer's "Fortschritten der Medicin," 1886; Grashey, "Archiv. f. Psychiatrie," 1885; Lichtheim, "Deutsch. Arch. f. Klin. Med.," Bd. xxxvi.

† "Virchow's Arch.," Bd. ci.

‡ "Archiv. f. Psych.," xx.

movements of expression, such as bobbing the tail. Nothnagel* believes, that the centre for the mimic expressive movements is located in man in the thalamus opticus, whereas the centre for the most complicated expressive movements is located in the cortex cerebri, the nerve-tract being chiefly in the pyramidal tract. The tract between the thalamus and the cortex, which would provide the psychical factor, is not as yet determined. Ziehen † believes, that certain expressive movements, such as the bristling of the hair, blushing, etc., probably have their centres in still deeper parts of the brain, particularly in the medulla oblongata. This, he says, harmonises with the fact, that these expressive movements also result from psychical causes, but are virtually not subject to the volition, or, more properly, to the process of association at all; they cannot even be voluntarily suppressed.

Of the various forms of aphasia we have already spoken. Undoubtedly, it is to the study of such conditions as word-blindness (*alexia, coccitas verbalis*) and word-deafness (*surditas verbalis*) that we are to look for some clue as to the localisation of events revivable in memory. In word-deafness the patient does not hear words, but hears other sounds, and is not deaf. In word-blindness there is inability to understand printed or written words, or familiar objects, although he can see quite well. Lichtheim has pointed out, that the "auditory word-representations" form the starting point of language. Auditory images and motor images must be combined in order that an imitation of a sound may be produced.

The physical equivalents of ideas of articulation are supposed to rest in the posterior inferior part of the frontal convolution. When this part of the brain is destroyed the power of moving the apparatus of speech is retained, but the individual is unable to articulate any word. For the complete utterance of articulate language it is essential that this latter region should be intact. Similarly, as we have seen in a previous chapter, it is essential that the regions for acoustic and visual images should also be working normally. In the case of visual images both hemispheres of the brain are

* "Zeitschr. f. Klin. Med.," 1889, Bd. xvi. H. 5 and 6.

† "Sphygmograph. Untersuchungen," 1887.

involved, whereas the images of articulation and hearing appear to be deposited in one hemisphere only (in the left hemisphere in right-handed persons). For the complete conception in consciousness and the due utterance of articulate language, therefore, it is essential that the regions concerned with the reproduction of the images, both sensory and motor, should be intact, and that the tracts of communication with the higher perceptive centres should also be normal.

It is hardly necessary to return to the question as to how the component parts of the idea of words become associated as a general concrete conception. We know so little about the formation of simple perceptions from a physiological point of view, that we naturally hesitate to attempt to explain the formation of a general concrete conception such as is involved in articulate language. The view of Hughlings-Jackson, that words are revived, in silent thought, as faint articulatory processes taking place in motor centres, need not be discussed, inasmuch as it would only involve a repetition of the arguments against the existence of actual outgoing currents, or feelings of innervation. The fact, that some people read aloud, or give articulate expression to their thoughts, is obviously no evidence in favour of the theory. We agree with Bastian, who believes, that there are good reasons for rejecting the notion, and that the materials of our recollection, in the idea of words during silent thought, are revived articulatory sensations. The arguments we have given as to the nature of ordinary revived kinæsthetic sensations apply equally well to actual speech. We are aware of the importance to be attached to the joint operation of the auditory and visual apparatuses in the development and production of speech, and we fully appreciate the fact, that total deafness supervening in a child in full possession of speech, as late as the fourth, fifth, or even the sixth year, will entail dumbness; but that a revival of the auditory impression is not essential to acquired articulatory speech is evidenced by the fact, that the auditory word-centre may be affected without any impairment of articulation.*

* Bastian, however, does not attach too much importance to the auditory impressions in the production of articulate speech; his remarks apply rather to the revived images of silent thought.

Before leaving this part of our subject it is essential that we should speak briefly of some of the clinical disorders of the kinæsthetic word-apparatus. We have already discussed the auditory and visual word-apparatuses and their aberrations of external and internal origin, and when we take into account the lowered or excessive activity of them as associated even with various states of health, and also include the possibilities of their being affected by the excitability of the perceptive centres supposed to exist elsewhere, we can more readily understand how morbid presentations and representations arise in the insane.

Speech movements and writing movements may be affected secondarily through lesions of the auditory or visual word-centres of the associative or thought-processes, or through lesions of the kinæsthetic word-centres, which serve to transmit the impressions derived from the active expression of our thoughts by speech or writing.

Clinically, we have to note—(1) *deaf-mutism* as the result of congenital disease. Idiots may never acquire the power of speech. In some cases this is the result of disease before or after birth; in others it is merely the result of deafness. Many idiots only acquire the power about the fifth or sixth year; others have acquired the power, but lost it again owing to deafness supervening. It is common to meet with idiots who can hum tunes, but who cannot repeat words. The auditory apparatus may be quite normal, and there may even be a certain amount of musical taste in idiots; but there is not a parallel development of the vocal articulatory apparatus. Ireland observes that, in idiocy the gift of speech bears a pretty well-marked relation to the number and complexity of ideas. He describes a certain class of "idiotic aphasiacs" who remain obstinately mute, although they have more intelligence than other children who talk volubly. In spite of the fact, however, that they are often able to hear and to understand speech, these cases do not make much progress. In some cases the defect is attributed to a want of power over the muscles of the tongue. Sir W. Wilde* has pointed out, that in many instances of defective articulation,

* "Aural Surgery and Diseases of the Ear," London, 1853, pp. 465–7. Ireland, op. cit., pp. 274–6.

as well as severe stuttering and of partial mutism, there is a peculiar narrowness and an unnatural height of the palate immediately behind the upper incisor teeth. As a rule, idiots cut their sentences very short: sometimes they confine their remarks to monosyllables. Another characteristic feature of their speech is that, when asked a question they repeat the question several times before they recognise its import and attempt to reply. (2) *Acquired defects* of speech may supervene at any period of life. Lesions of those parts of the brain connected with the associative apparatus of thought may so alter the intelligence as to render speech defective; or the defect may lie in the articulatory apparatus (the kinæsthetic word-centre, as well as the mere motor tract). Stuttering and stammering are usually the results of defective co-ordination of the articulatory movements. Aphemia is generally the result of defective movement alone. It is common in glosso-laryngeal paralysis and other diseases of the medulla oblongata; it may also occur in association with paralysis from cerebral disease, general paralysis of the insane, disseminated cerebro-spinal paralysis, and hemiplegia, either cerebral or pontine. A lesion of one of the oro-lingual centres of Ferrier causes oro-lingual hemiparesis, which is characterised by slight unilateral weakness, and not by complete paralysis. When the lesion is on the left side of the cerebrum speechlessness results. The effects of lesions in the island of Reil, and the not uncommon association of aphasia with heminanæsthesia of the right side of the body, are subjects of great import, but we cannot discuss them here.

In the insane we have to note the following varieties of speech:—(1) The slow and often difficult way of speaking in melancholiacs, and sometimes also in the feeble minded; (2) the incessant and rapid talking of maniacs and general paralytics *(logorrhœa)*; (3) *alliteration* (Mendel), the derangement in which words are not placed according to their meaning, but according to their sound; (4) *verbigeration*, in which there is monotonous utterance of incessantly repeated words (Kahlbaum), the words being in some cases forcibly enunciated in an extremely strained manner, and with evident difficulty (Neisser);*

* "Tuke's Dictionary," p. 1355.

(5) Neisser describes *mutism* as being an important symptom in katatonia. The patient remains silent for months or even years; there may be a desire to speak, but inability to do so. Verbigeration not infrequently supervenes upon this mutism. (6) *Akataphasia* is the term applied to that form of speech in which the individual speaks of himself in the third person, common in Scotchmen, and in idiots; (7) mutism in the insane may be due to deaf and dumbness, absence of ideas, or the presence of delusions. Such delusions may be hallucinatory in origin, and in the form of a special mandate to maintain silence; or they may be hypochondriacal with a fear of the consequences of speech.

Clinically, we have to note also, that speech defects occur: (1) As spasmodic stuttering or stammering in childhood, either as a temporary or permanent defect. Bristowe regards such defects as due mainly to imperfect training, to bad habits or slovenliness, or to some defect in the relations between the ear and the organs of articulation. When it arises in adult life, he attributes it to an attack of fever or other acute disease, to hysteria or some other nervous disorder, to nervousness or excitement, or even to temporary soreness of the tongue or lips, or other parts engaged in articulation. Among other defects of speech due to bad habits, or imperfect education, he enumerates, the habits of interpolating such expressions as "You know," "I mean," etc. (2) As a characteristic tremulousness or stammering in alcoholism. This condition closely simulates the speech of general paralysis, but there is difficulty and embarrassment rather than true ataxy. Tuczek has described the occurrence of grandiose ideas with motor and speech derangements in ergotism, simulating cases of general paralysis. Toxic agents such as quinine, chloral, atropine, iodoform, etc., have been described as giving rise to speech perversions, either increased volubility, incoherency, or embarrassment. Atropine sometimes causes difficulty of articulation, whilst iodoform has caused actual aphasia (Legrain). (3) Speech-changes following enteric fever have been described by Colin M. Campbell, who found a distinct impairment of speech co-ordination during excitement and fatigue, and, that this state continued for some months after the fever. Mickle has also described certain post-febrile speech defects which simulated those of general paralysis. A slow speech with deliberate drawling, and articulation of the syllables in a monotonous tone, and with a nasal twang, has been noted by the author as following typhoid.* Westphal noted after typhus the scanned, nasal, and monotonous speech, in which the letters and syllables were not displaced, but separated by intervals and uttered jerkily, or with visible efforts, yet, as after typhoid, without co-existing tremblings of the lips and face. (4) The dyslogic and articulatory defects met with in general paralysis are characteristic, but space will not permit us to describe them here.† As a rule, the presence of tremors of the lips, and the characteristic drawl, serve to distinguish the speech of the general paralytic from that of patients suffering from disseminated sclerosis. Cases of bulbar paralysis exhibit speech defects very similar to those of general paralysis, and often by themselves difficult to diagnose. (5) The photisms of the sounds of speech have already been considered. It is interesting to note further, however, that vowel sounds are more apt to give rise to photisms than consonants. Photisms for entire words have been described by Bleuler and others. The readiness with which photisms and phonisms are produced is suggestive of a possible explanation of several forms of sensory perversion in the insane, and assuredly, in the not very far future, we shall have some more definite account of the relationship between the activities of the special senses and the kinæsthetic impressions. (6) Aphasia may occur as a transient condition in association with the hemiplegia of children. Such transient alterations of speech have been noted in hereditary syphilis, and in one case recorded by Barlow and Bury‡ there was thought to be endoarteritis of symmetrical branches of the middle cerebral arteries and degeneration of the cortical centres, especially of the third frontal of both sides. (7) Special affections of speech, either of a temporary character immediately following an attack of sunstroke, or as a continued impairment or failure in development of the faculty, have been described by the

* "Tuke's Dictionary," p. 986.

† See Mickle, "Tuke's Dictionary"—"General Paralysis."

‡ "Tuke's Dictionary," p. 1265.

author.* The somatic sequelæ of sunstroke may include tongue tremors, and thickness or slurring of speech very similar to those in general paralysis. (8) In sleep and its associated conditions, a person may speak and sing in a perfectly automatic way without involving an element of waking consciousness. Owing to the kindness of Dr. Bramwell, the author was able to witness the artificial production of every variety of amnesia and aphasia in a hypnotised person. The suggestions were made during hypnosis, and the effects were manifested during the post-hypnotic state when the patient was only imperfectly roused.

Conduct.—We have seen how voluntary movement is related to impulsive movement, and we have come to the conclusion, that voluntary movements of the body imply a considerable development of the mental activities of ideation and volition; but we do not know the physical basis of volition. We may, with the advance of our knowledge of the localisation of cerebral function, arrive at some more definite conclusions as to the structures concerned with the carrying out of an act of volition, but we are not so hopeful with regard to our prospects of ever knowing what molecular changes are correlated with the psychical elements. The theories hitherto given as to the nature of the will—those explanations which have sought to show that voluntary motions follow upon certain ideas or excited states of feeling, without a conscious fiat of the will—serve to illustrate the nature of truly impulsive actions. If we regard such actions as voluntary, we find ourselves in the difficulty of having to differentiate psychologically between such activities and those which involve an element of conscious choice. We do not know what happens in the brain when the fiat of will issues in consciousness. The phenomenon is something above, or in addition to, mere forced attention, and it is unwarrantable to assume that the fiat is a purely mechanical state dependent upon the influence of mechanical stimuli.

A complete study of conduct would involve the consideration of the various forms of action and resistance, together with the psychical elements known as the *motifs* and *fiats*, or, in other words, the whole of the physical and psychical factors which

* "Sunstroke"—"Tuke's Dictionary," p. 1234.

serve to bring about the adjustment of the organism to its environment. The physiological methods by which internal processes of the organism are adjusted to one another, and by which movements are brought about, are little known to us. The psychical methods, on the other hand, by which the organism is consciously adjusted as a whole to its environment, are more easily demonstrated.

The nervous mechanism of conduct has already been considered, and we have tried to understand the nature of the processes in the highest nervous centres, by which the acts of the organism are adjusted to external circumstances. We may say, briefly, that the appropriateness of individual conduct depends upon (1) the proper working of an educated reflex or automatic mechanism; and (2) the proper physiological and psychological adaptation of the nervous system and the mind to the environment.

Mercier says of a reflex act, "It is an act that was once intelligent, that was once preceded by deliberation, by choice, and by will, but that in the course of innumerable repetitions in the lifetime of many generations has become first habitual, then automatic, and finally reflex; and to this end all our acts are tending." * In another place he says, "If there is anything certain in life it would appear to be that we move our limbs and speak our thoughts by an effort of will, and that in this case, undoubtedly, the mental process is not only the forerunner, but the actual cause of the bodily movement. It is not so, however. . . . . The exercise of the will, which appears to be the cause of bodily movements is, in reality, the mental shadow of the particular nervous process which really is the cause." † In the first quotation, deliberation, choice, and will are regarded as essential to the development of reflex action. In the second, however, these factors are regarded as the effects, or "mental shadows," of nervous activities. In yet another place he speaks of the intensification of nascent activities, "all of which are striving, as it were, to become actual and to produce movement. . . . . At length, owing to the nature of the impression, and to the direction of paths previously traversed by

* "The Nervous System and the Mind," p. 166.

† "Sanity and Insanity," pp. 53, 54.

currents in circumstances somewhat similar, one of these struggling centres gains the preponderance. The fittest survives. The tension among the bursting centres is relieved by the discharge of one of them, and thus the nervous accompaniment of volition is not merely a discharge of a single centre, but a discharge which follows a struggle for preponderance, and marks the triumph of one of the conflicting factors. Hence, this feeling arises not only when actual movement follows this successful struggle, but arises also in a somewhat modified form when a similar struggle takes place on a higher plane of nervous action, and terminates in the preponderance of one of the struggling activities, without that activity finding immediate expression. In other words, volition or willing comes to be the feeling which accompanies the termination of a struggle among nascent activities by the preponderance of one, just as hesitation is the feeling that corresponds with the duration of the struggle." Here we leave this discussion, in the hope that the struggle for preponderance of these conflicting statements may awaken among the nascent activities of the student a tendency to react in the right direction. That one or other of these factors will be successful we do not doubt; we only trust that the right nascent activity may be intensified, that is, if he is to be denied the freedom of choice.

Much of the confusion about the actual mental state that precedes voluntary acts arises from the fact, that an insufficient distinction is made between the guiding and instigating effects of kinæsthetic impressions. Kinæsthetic impressions are guides only; they do not instigate movements. In the exercise of voluntary movements the conscious accompaniments are epiphenomena, and there is every grade of mental accompaniment, ranging from so-called ideo-motor to true voluntary activity. According to Ladd, voluntary movement implies (1) the possession of an educated reflex-motor mechanism, under the control of those higher cerebral centres which are most immediately connected with the phenomena of consciousness; (2) certain *motifs* in the form of conscious feelings that have a tone of pleasure or pain, and so impel the mind to secure such bodily conditions as will continue or increase the one, and discontinue or diminish the other; (3) ideas of motions and positions of the bodily members, which previous experience has taught us, answer more or less perfectly to the *motifs* of conscious feeling; (4) a conscious fiat of the will, settling the question, as it were, which of these ideas shall be realised in the motions achieved and positions attained by these members; (5) a central nervous mechanism, which serves as the organ of relation between this act of will and the discharge of the requisite motor impulses along their nerve-tracts to the groups of muscles peripherally situated.

In our estimation of conduct we must distinguish between acts and their effects. Sane individuals are liable to faulty and inaccurate psychological adaptations of the organism to the environment; hence, imperfection of movement or fallacious reasoning is not necessarily an evidence of insanity. In every asylum patients are to be seen whose ordinary conduct is conventional in the extreme: moreover, they may possess a degree of intelligence and will-power superior to the sane, yet who are unable to manage themselves or their affairs. We have observed dements and even general paralytics rally after a period of apparent mental dissolution and converse rationally for a time, without exhibiting a trace of their recent insanity. In the wards of an asylum we see every variety of conduct, and witness the extreme limits of control, as well as of abandonment.

If the student will refer to the following chapters which deal with the factors of the insanities, and build upon them the knowledge he has acquired of the development of morbid mental states, and then apply the rule, that exercise strengthens function, he will be able to recognise how a given set of circumstances arouses by its impress on the organism the same reaction that it has previously roused. Further, by applying the law of the "survival of the fittest," not only to stimuli, but also to their effects, he will be better able to understand how successful acts tend to be repeated, and unsuccessful acts to be suppressed. Among the insane, the novel and often amusing combinations of actions are explained as the adaptation of old ways of meeting some circumstances, to circumstances of a totally different nature.

The conduct of the insane is usually determined either by the co-operation or the opposition of impulses. The existence and co-operation of motives derived through some ideational or emotional derangement will often determine and further a special line of conduct. Conflicting impulses, on the other hand, may cause a cessation of activity, and even a temporary paralysis of volition. We have already spoken of the effects of doubts, deterrents, and the rivalry of impulses in their relations to simple and complex actions, so that it only remains for us now to give some account of the state known as *self-control.*

The will is able to check action or impulse by the voluntary exertion of an inhibitory or contra-action. The action which, in the natural course of events, would follow upon a motor idea can be inhibited by the will, by the exertion of another positive activity which checks the ideo-motor activity. Defect in this controlling influence renders an individual liable to become a passive participator in impulses which range from mere rashness to homicide. An individual with imperfect control is apt to act on the spur of the moment, and to respond to every stimulus from without. In acute mania, active impulses, inability to inhibit sensory stimuli, and almost constant restlessness, are characteristic symptoms. In these instances there is loss of the higher order of development of the faculty of control—*i.e.*, there is no subordination of the particular and temporary ends to the general and permanent interests.

Control of the feelings is often a much more difficult matter. There are times when it is well-nigh impossible to control our emotional reactions. Undoubtedly, however, it is among the insane that the feelings are wont to play the greatest pranks. Emotions literally take possession of our muscular system, so that a greater expenditure of energy is necessary in order to overcome their effects; and, moreover, the intensity of the emotion tends to weaken the force of the will from the psychical side.

Perfect control of thought presupposes not only the faculty of attention, or fixation, or focussing representations before the mind, but also perfect control of feeling. Ferrier says the internal diffusion of nerve-energy involved in thought, and the external diffusion of it in muscular action, vary in an inverse ratio; consequently, in the deepest attention, every movement which would diminish internal diffusion is likewise inhibited.

Hence, in deep thought, even automatic actions are inhibited, and a man who becomes deep in thought while he walks may be observed to stand still. Mercier objects to the expression "loss of control," and seeks to reduce what we accept as a fact of psychological significance to its equivalent in molecular physics. This physical equivalent he finds in the stability of a mobile equilibrium of atoms. Reference might with advantage be made by the student to the quotation on p. 147, in which the same author demonstrates that similar hypotheses are, to use his own expression, "nonsense."

The amount of force which can be overcome by an effort of the will is the test whereby the strength of the will is measured. Some individuals are unable to resist forcible stimuli coming either directly from without, or indirectly by the association of ideas. An increase of the force to be overcome, or an impairment of the power of overcoming that force, may determine loss of control. This is well shown by Ribot in respect both of the loss of control over impulse, and of the impairment of control of the attention and the flow of ideas. In mental diseases there may be loss of self-control in a psychical sense, or defective inhibition in a physiological sense (as, *e.g.*, in impulsive insanity, and maniacal states); or, on the other hand, there may be defective energisation or loss of power of exciting activity (as in stupor, melancholia, etc.). Clouston puts it clearly when he says, "The driver may be so weak that he cannot control well-broken horses, or the horses may be so hard-mouthed that no driver can pull them up." In some cases it is difficult to say where the defect lies.

Clouston states, that in the young "there is absolutely no such brain-power existent as mental inhibition; no desire or tendency is stopped by mental act." Later, he says, "The power of control is just as gradual a development as the motions of the hands." With the latter statement we agree, and, in conformity with the fashionable phraseology of the day, we may posit the rudiments of mental inhibition as a "nascent state" with the first act of life. The processes of experience of the physical activities are parallel with those of the mental. There is no period in the life history of an individual when physical or mental inhibition can be said to develop as a supernumerary factor. The parallelism must be complete from the beginning; the "nascence" of one must coexist with the "nascence" of the other. When dealing with the minds of idiots and imbeciles, however, we are scarcely warranted in assuming that their mental defects may be only nascent potentialities of the powers of a Mozart, Darwin, or Spencer.

In mental disease loss of self-control is often a characteristic symptom. The loss of power of inhibition, viewed physiologically, may be due to causes which interfere with the due regulation of the physical activities; and in dealing with such modes of activity, we have to take account not only of the molecular physics and the possibilities of decomposition of unstable matter, but also the special molecular physiology which would correspond to what we term "life." The loss of power, when viewed psychologically, however, involves the consideration, not only of the phenomena of physics and life, but also of the epiphenomenon of mind. As we have already seen, it is utterly impossible to explain life by the mere enumeration of its physical manifestations, and it is just as impossible to explain mind by the enumeration of the manifestations of life. *We cannot explain the will by the mere enumeration of the contents of consciousness preceding the actual performance of a voluntary movement.* So long as we view self-control from a purely physiological point of view, we must of necessity view the mind as a mere passive spectator of the conflicting activities going on within the organism. Mercier asks us to try to imagine the idea of a beefsteak binding two molecules together. Of course, it is impossible. We only ask in return, try to imagine two molecules binding themselves together so as to produce an idea of a beefsteak. Simply because there is no community in nature between the two series of events, such a conception is regarded as unimaginable; and yet we are told almost at every turn that the physical series can regulate its own activities, but that the mental cannot do so. Here, again, unless we develop a disposition to materialism, we must grant that the parallelism between the brain and mind series of events is complete; otherwise we decide arbitrarily that the activity of the inevitable molecule is the cause and not the concomitant of the psychical event. The tendency of most writers upon this vexed question is, to discontinue the parallelism after they have reached a certain stage in their inquiries. Mercier appears to regard the exercise of the will as merely "the mental shadow of the particular nervous process which really is the cause"; thus making the nervous structure the guiding and controlling mechanism, the mental equivalent being only a shadow of what takes place. The relationship of the molecule to its mental shadow is particularly susceptible to speculation, and it is only reasonable to assume, that the mental shadow may, in its turn, be a motor or inhibitory one. In fact, an inhibitory mental shadow is a necessary correlate of a physical inhibition. That one factor is essential to the existence of the other, we believe; but we have no more authority to state that a material action can throw an immaterial shadow, than we have to state that an immaterial action can throw a material shadow. Both are shadows, so far as we are concerned, and we do not understand their nature.

For an account of the so-called "fulminating psychoses," or states of defective inhibition, the student is referred to the various text books on insanity. It is in the insane that we meet with the most marked evidences of the existence of a will which may become violently affected or rendered altogether inert. That this is coincidental with some impaired vitality, we do not deny; we merely stop short at the arbitrary decision that the *manifestations* of what we conveniently term the "will" possess any causal efficacy.

Let us now briefly sum up what we can, with perfect fairness, assume as to the existence of a will. (1) There are no grounds to assume that a will exists *for us independent* of physical or physiological activities. Matter, life, and mind are for us empirical correlative states, developed in a parallel series, and capable of manifesting their existence by activities, which are respectively equally complex. Any attempt at explanation of the one in terms of the other results only in confusion, or in an implied causal influence. (2) The fact, that the point to which the will is directly applied is always an idea, is no proof that the idea always determines the application of the will. The idea itself is the mental equivalent of the instrumental means whereby the fiat becomes realised. Were this otherwise, the responsibility of remembering, comparing, and determining action would rest upon an idea. The struggle for survival among ideas is not one in which one idea has summed up the perfections or imperfections of other ideas, and has decided that its action is the one best fitted for the conservation of the organism. It does not, without the word of command, ride astride its material basis of "stable mobile equilibrium of atoms," and merely inform the *ego* of what it is doing. That the idea immediately precedes the action, we believe; but that it causes the action is another matter. The ideas are the elements in consciousness from which the *ego* derives its knowledge of conflicting influences. It would be difficult to demonstrate, that ideas themselves possess the faculty of comparing themselves with other ideas, or that the continuity of a life experience is only an integral part of an idea. Here again we repeat, that just as in the leading principles in modern natural philosophy the terms attraction, gravitation, cohesion, etc., are used to represent the various manifestations of material movements, and just as the terms currents, mobile equilibrium of of atoms, inhibition, etc., are used to represent physiological manifestations of what we symbolise as life, so the terms intellection, emotion, and volition are used to represent psychical manifestations of what we symbolise as the individuality, or the *ego*. (3) The outcome of the contentions is one of vast importance both to speculative theology and to science. On one point we are perfectly clear. The all-pervading condition of ignorance by which we are surrounded, most effectually prevents us from giving vent to one-sided dogmas, either in the cause of materialism or spiritualism. We can only contemplate the phenomena of matter, life, and mind as they exist for us, and avoid being blinded in our view by molecular dust or the film of fantasy.

In concluding this chapter we may note that **Impairment of the will** may manifest itself as a condition of *irresolution*. This may be due to (1) weakness of motives or incitements; (2) various states of doubt as to the nature or result of the action to be performed; (3) excessive number of ideas, which tend to delay and counterbalance the impulsion to act in a definite direction.

Ribot* divides diseases of the will into two principal classes, according as the will is impaired or abolished. *Impairment* of the will may be due (1) to lack of impulse, or (2) to excess of impulse. Guislain,† Griesinger,‡ Leubuscher,§ Esquirol, Carpenter,‖ Ribot,¶ and Billod** have made observations upon the first group. When a patient is able "to will" to act, or when the desire is present, but the impulsion to carry out the act is absent, the condition is known as *aboulia*. One patient, formerly an inmate of Bethlem, used to lament this inability to act. She was able to understand and reason upon her ordinary experiences without any observable impairment of intelligence. She was, however, unable to put into effect the result of her deliberations, and the desire to react to circumstances proved ineffective. Not uncommonly, such patients believe that their will is taken possession of by others, or that their actions are inhibited by some mysterious influence. Ribot believes, that the muscular system and the organs of movement remain intact; they offer no impediment. The automatic activity which constitutes the ordinary routine of life persists. The difficulty appears to be in passing from the consciousness of a desired end to the action which would presumably acquire that end.

The cause of this impotence of will is at present a matter of considerable doubt. Some authors maintain, that the affection is mainly due to impairment of the motor centres in the brain, and that it is the motor apparatus which is at fault. This theory, however, is generally held to be unsatisfactory. Certain it is, that patients affected with *aboulia* are not necessarily deficient in guiding sensations or ideas of the movements which they are unable to perform. Ribot maintains, that there is principally an impairment of the incitements to action.

* "Diseases of the Will," chap. ii.
† "Leçons Orales sur les Phrénopathies," vol. i. p. 479.
‡ "Traité des Maladies Mentales," p. 46.
§ "Zeitschrift für Psychiatrie," 1847.
‖ "Mental Physiology," p. 385.
¶ Op. cit. chap. ii.
** "Annales Médico-Psychologiques," vol. x.

The condition may not be due to weakness of the desire to act, but we do not concur with Ribot, that the aboulia invariably results from the absence of the states of feeling and sentiment which normally accompany every sensation and idea. In some cases of aboulia—especially in melancholia and stupor—there is a comparative insensibility, or even absence of the general sensibility; but again, in other cases, patients have been not only morbidly desirous of performing certain actions, but even highly sensitive and morbidly susceptible to the emotional accompaniments of ordinary sensations.

The performance of the actual action itself is purely physiological, but the perception of sensations and their accompaniments is psychical. We can hardly suppose that a pure state of consciousness is of itself capable of producing action or prohibiting it; but, were we to eliminate the various mental states which we symbolise as "will," the complicated adaptive, delayed, and purposive actions performed by the human being would be nothing short of miraculous. In fact, to whatever extent the physiological theory of will be urged, it must always fail to give an explanation of those empirical psychical factors which we denominate as the will.

The sense of fear acts as a deterrent of action. In such cases the incitement to act is not necessarily absent. The power of *reacting* to circumstances seems, however, to be entirely lost. Often there is no cause for the fear, but the motor apparatus is thrown completely out of gear for a time.* *Agoraphobia*, for example, is a condition of anxiety which, as previously mentioned, renders a person powerless when he sees an open space. A condition similar in its effects to that of fear is sometimes witnessed among troops of men on active military service, and more particularly during the course of a fatiguing march. Suddenly, and without any apparent cause, a panic seizes the men, and they halt in almost breathless silence. An old Indian officer has narrated many instances of this to me, and he states, that the panics are usually only momentary;

* Westphal, "Archiv. fûr Psychiatrie," vol. iii.; Legrand du Saulle, "Annales Médico-Psychologiques," 1876, p. 405; Ritti, "Dict. Encycloped. des Sciences Médicales," art. "Folie avec Conscience"; Ribot, "Diseases of the Will," p. 15 (Humboldt Series).

for, at a word from the commanding officer, the men generally pull themselves together, and, with a laugh, again fall into step.

We now pass to the consideration of the second group of cases, in which there is impairment of the will through *excessive activity of the mechanism of impulsion.* The degree of consciousness of the operation varies considerably with different cases. Thus, the impulse may be sudden and without any forethought: the individual performs an action which is closely allied to the instinctive. In epileptics, hysterical maniacs, and in some forms of weakmindedness, with sudden explosive outbursts, we find numerous instances of such excess of impulsion. Some patients, after an attack of an acute mania, will volunteer the information, that they were conscious of their actions throughout the whole attack, and that they could not account for the extraordinary things they did. Others are fully conscious of their own condition, and feel bound to perform certain actions which they at the same time condemn. A patient was brought to Bethlem bound hand and foot, at his own request, in order to prevent self-mutilation, which proved an ungovernable impulse to him. Another patient begged and implored that mechanical restraint might be employed to prevent him injuring himself. Instances of this kind are numerous; and not infrequently patients will state, that the employment of some restraint to their actions has been a great source of relief. The fear of committing suicide, or of killing someone, often prompts patients to place themselves voluntarily under restraint. Thus, for instance, a barber, admitted recently to Bethlem, felt the almost irresistible impulse to cut the throats of his customers while shaving them. Other examples, such as those of pyromania, kleptomania, etc., are so common that they need scarcely be referred to.

Intoxication by alcohol is especially productive of excessive impulsions. The usual explanation is, that the power of inhibition is impaired, and that the reflex actions become excessive or violent as the case may be. The numerous cases recorded as instances in which the higher regions of the brain have been injured and the brain impaired have furnished several writers with the idea, that the will-power occupies a distinct locality in the brain. Ferrier has recorded a case in which, through injury to the præfrontal region of the brain, a patient lost the balance between his intellectual faculties and his instinctive tendencies. He became nervous, disrespectful, and grossly profane. He showed but little politeness to his equals, was impatient of contradiction, and would listen to no advice that ran counter to his own ideas. At times he was exceedingly obstinate, though capricious and indecisive. He would make plans for the future, and forthwith reject them and adopt others. He was a child intellectually, a man in passions and instincts. Before the accident, though he had not received a school education, he had a well-balanced mind, and was regarded as a man of good natural abilility, sagacious, energetic, and persevering. In all these respects he was now so changed that his friends said they no longer recognised him.

Ribot remarks, that in this case the will is impaired in proportion as the inferior activity becomes stronger. In all theories which seek to demonstrate how morbid symptoms arise as the result of activities within the undamaged remaining cerebral substance, we meet with the assumption, that all that is vicious, distasteful, and immoral is to be attributed to activities within these undamaged regions. In fact, some authors, in their endeavours to affix the physical evidences of dissolution to physiological factors, involve themselves in hypotheses as to the relative functions of nervous structures which, on analysis, prove to be not only fanciful, but even absurd. Of these hypotheses, however, we shall speak more particularly in remaining chapters.

Clinically, we have to note the following types of morbid impulse*:—(1) General impulsiveness, or the tendency to react immediately to all sorts of external or internal stimuli. Patients of this type break windows, strike others, and are continually getting into mischief. (2) Epileptiform impulses which are unconscious in character, or, in which, at any rate, the patient is unable to recall the reasons for, or the nature of, the impulsive act. (3) Sexual impulses, which include the excessive tendencies towards sexual intercourse, onanism, bestiality, etc. (4) Morbid appetites in which

* Clouston, "Mental Diseases."

patients are unable to resist eating and drinking all sorts of filth. (5) Homicidal impulses. (6) Suicidal impulses. (7) Dipsomania, kleptomania, pyromania, etc. (8) Impulsive conditions which alternate with forms of intellectual or moral insanity.

In some instances the morbid impulse is preceded by an aura similar to that of epilepsy. According to Bevan Lewis,* the morbid sensation is often peripherally referred, is of sudden accession, and may rapidly pervade distant parts of the body. Taylor,† Skae, Pinel, and Maudsley‡ have described the occurrence of various *auræ*, such as burning heat in the epigastrium, constriction of the throat, colicky pains, flushings of blood to the brain, cold waves on scalp, etc.

At certain critical epochs of life—*e.g.*, puberty, climacterium, and at menstrual and puerperal periods—there is often a tendency to excess of impulsion. According to Bevan Lewis,§ homicidal impulses may prevail in one of four conditions in the epileptic subject—viz.:—(*a*) in epileptic furor or mania, associated with hallucination or delusion; (*b*) in the so-called "epilepsia larvata" (Morel), the "masked epilepsy" of Esquirol; (*c*) in the dreamy state of epilepsy; or, lastly, (*d*) as a simple impulsive derangement during the inter-paroxysmal period.

In the insane the various forms of morbid impulse are commonly found as follows:—(*a*) The impulse to destroy, in mania, imbecility, moral insanity, and dementia; (*b*) epileptiform impulse, in epilepsy, early stages of general paralysis, in the neuropathic diathesis generally; (*c*) sexual impulses—satyriasis in the male, nymphomania in the female—in maniacal states, at puberty, adolescence, climacterium, and at the senile epoch: (*d*) morbid appetites—associated with menstruation, pregnancy, puerperium, and lactation, in acute mania, general paralysis, and in imbecility; (*e*) homicidal impulses — in imbecility, masturbatic insanity, puerperal,

* "Text Book of Mental Diseases," p. 180.
† "Med. Jurisprud.," vol. ii. p. 553.
‡ "Responsibility in Mental Disease," p. 141.
§ Op. cit., p. 185.

epileptic, traumatic, alcoholic, religious, and delusional insanities.

Aboulia is commonly found in simple melancholia, or in the early stages of mania, or of general paralysis. Hyperboulia is usually manifested as a condition of wilfulness in states of mental exaltation with excitement; also in some forms of weak-mindedness and delusional insanity.

CHAPTER XIV.

The Factors of the Insanities.

Growth and Development of the Mental Faculties — Developmental Processes in the Infant—Microkinesis—Micropsychosis—Reversion in Adults—Factors of Development. *Internal Factors*:—Original Capacities—Genius—Degeneration and Genius—Balance as the test of Mental Health—Genius a Sociological not a Psychological Concept—Hallucinations not Incompatible with Sanity —Mental Health not to be Estimated Entirely from an Objective Standpoint—The Degenerate Advocates—Unreliability of Statistics—Inherited Dispositions—The Views of Spencer and Weismann—Hereditary Factors in Insanity—Consanguinity—Phthisis, Scrofula, Gout, Rheumatism, Syphilis — Alcohol — Diabetes — Neurotic Manifestations. *External Factors*: — Social Environments — Psychopathic Epidemics — Children's Pilgrimages — Lycanthropy — Raphania — Sensory Types — Religious Impostures — Sympathy and Mimicry — Endemic and Epidemic Psycopathies — *Folie à deux* — Religion — Physical Environment: Seasons—Climate—Occupation—Town and Country Life.

THE FACTORS OF THE INSANITIES.

In speaking of the development of mental states, or of the human faculties, we must fully recognise that, as in the case of the physical organism, there is no parallelism between *growth* and *development*. Mind is said to grow when it increases its stock of materials; when it elaborates its materials into higher and more complex forms it is said to develop. With abnormal growth, development is sometimes impeded—*e.g.*, in preparing for examinations the excessive growth of the bulk of retentions may, for a time, impede true mental development; just as an excessive amount of nutriment may produce fatness, while, at the same time, rendering the physiological activities more sluggish. When the mental retentions are elaborated, and their intellectual bearings reduced to the abstract, development results. If, however, they remain as mére retentions, growth results; and, just as with physical corpulency, we have lessened bodily activity, so with mental agglomeration, we have diminished power of thought. The development of the mental faculties involves an increased facility and rapidity of acquired processes, requiring less effort or activity on the part of the executive mechanism: new operations of the same grade of complexity become easier; and with the increased capabilities, new operations of greater complexity and difficulty are more readily effected.* Exercise helps the physical organism to grow and to develop, and so with the mind, "exercise strengthens faculty."

How brain activity is brought about, or how it reacts on the particular structures engaged, we do not know: we can only assume, that with each activity some modification or physical disposition to act in a similar manner is created. The mechanical law is true under any conditions, and the repetition of the flow of nerve energy in definite directions gradually exerts a disposition towards activity being propagated along these lines of least resistance.

In order that we may obtain some idea of the morbid processes of development of the mental faculties, it is advisable that we take into account the developmental processes in the infant. Warner† has endeavoured to trace, from the movements of infants, indications of action in the nerve-centres, and thereby to demonstrate their spontaneity and impressionability to forces acting upon the organs of sense. By noting the attributes of the actions seen in series of movements as the evolution of the individual advances, he concluded, that some spontaneous movements indicated conditions of growth, while others were indicative of development of the mental faculty. The spontaneous ("microkinetic") movements of the infant he regarded as analogous to the spontaneous movements in all young animals.‡

* Sully, "Outlines of Psychology," p. 42.
† "Tuke's Dictionary," p. 465.
‡ "Journ. Ment. Science," April, 1889.

With regard to the indications of mentation as observed in the movements of the infant, Warner says :—

"Observation affords abundant evidence that the various members and parts of a healthy infant present constant movement while it is awake.

"These movements in the new-born infant are not controlled through the senses by sight or sound, but movements of respiration and deglutition are controlled by impressions on the skin and mucous membrane. At this early stage we do not observe the phenomena of delayed expression, cerebral inhibition, or compound cerebral action.

"It is commonly said that the infant at birth does not give expression to the faculties of mind because it does not present signs showing that its nerve centres are impressed, even temporarily, by the sight of surrounding objects, its hands do not move towards objects within the field of vision, and none of its movements indicate that they are controlled by sight or sound.

"When about three months old some control of movements through the senses may be observed, and the head may turn towards a bright light.

"There is not much capacity for adapted action.

"When the infant is about four months old, we find coming signs of impressionability to stimulation. Then the senses, the sight of objects, and sounds around, begin to control the microkinesis.

"In the new-born infant it may be assumed that there is no mentation, no memory, no will. It is intrinsically possessed of a certain histological structure, with its properties and powers of reflex action, microkinesis, susceptibility to impressions, received through the special senses.

"Compare the action seen at birth with that seen at *five months*. Microkinesis still continues, but is capable of control by stimulation through the senses; it may be arrested temporarily by sight or sound, and this, after many repetitions, may be followed by new series of movements occurring upon less and less stimulation, and with increasing quickness and accuracy as time goes on. We infer a corresponding change in the nerve-centres. It appears that, whereas at birth they act slowly and independently of one another—as far as we know without any order in their acting—and the time of this action is not determined through the senses, at the age of five months they may temporarily be suspended from action by external stimulation, and during the time when no apparent currents are passing from them, undergo a change indicated subsequently by special combination and series of movements. This appears a great advance in cerebral evolution.

"The following kinds of movements may then be seen in the infant:— Movements of the outcome of inherited conditions in the nerve-system (microkinesis). Movements following immediately upon stimulation by certain external agencies, as light, sound, etc. Movements resulting from the acquired association of nerve-centres. Movements similar to those previously resulting from a similar cause. Movements in different special areas, such as the small joints; asymmetry or symmetry of parts, etc. Action indicating delayed expression."

When we consider these visible movements as indicative of the evolution of the nerve-centres, the first question we ask ourselves is: What is the significance of the movements which are universal at birth? Warner says, "Each movement corresponds to actions in a nerve-centre, the mass of movements corresponds to a mass of nerve-centres in action. Further, these movements, as far as we can see, as to their time, and the parts moving, are not determined by forces around; that is, to say, the nerve-centres are not controlled in their attributes of action as to its time by external stimuli acting through the senses. We conclude that in the infant, in its earliest stages, the nerve-centres act separately and independent of special stimulation." Are we really in a position to say that there is no mentation, no memory, no will in the new-born infant? If with the first movement there is no corresponding first impression in consciousness, then we are in a position to assume that there is no mentation. This, however, we are far from being able to prove. Similarly with the second movement, which should bear some relation in consciousness to the first movement if it is taken as involving the primary element of memory. Unless, therefore, we postulate the occurrence of mentation at the very beginning we become responsible for an account of its appearance at a period somewhere along the succession of physical phenomena.

The term "*micropsychosis*" is applied to the neural action corresponding to a certain known mode of irregular, spontaneous uncontrolled thinking; but such an employment of the term is misleading, inasmuch as it is based upon an assumption which is unjustifiable, and would lead us to speak of matter in psychological terms. Because a mental act depends upon the formation of a didactic union among nerve-centres formed by stimuli from without or spontaneously, is no reason why we should term that physical process a psychical one. If we restrict the term to mean the *expression* of mentation as witnessed in movements of the infant, we do not improve matters. The latter is apparently the way in which Warner applies it. He says: "The expression of all acts of psychosis necessitates the kind of neural action termed compound cerebration; we cannot then expect to observe the expression of micropsychosis till we get evidence of acts of compound cerebration occurring in the evolution of the brain as evidenced by adapted action in its visible parts. The first little adapted actions in the infant indicate compound cerebration, and probably correspond to micropsychosis." From this it would appear, that the term "microkinesis" is applied to those movements which are spontaneous and purposeless, and "micropsychosis" to those which are adaptive.

The point we wish to be clear upon is, at what period of the evolution of the infant do the spontaneous movements become adaptive? Does the first spontaneous movement form the basis for movements which become adaptive? Or, to look at the question from another point of view, does the first adaptive movement *evolve* from some spontaneous movement, not at the beginning of the series, but at some later period? The answer to this is clear. Every adaptive movement must take its origin from the sum total of all the movements that have occurred before it; that is to say, with the first movement we have the starting-point of the evolution of adaptive movements, and the microkinesis, in its physical sense, is synchronous in origin with the micropsychosis in its psychical sense. Warner fully appreciates the very early occurrence of thought or micropsychosis. He writes:—

"The commencement of the rudiments of spontaneous thought in the evolution of the infant is not known to the physiologist—we cannot know the occurrence of thoughts before they are expressed by signs or words more or less like those used by adults. If thought depends upon the diatactic unions it may be assumed that such occur very early, for we see signs of them in combinations of the spontaneous movements of microkinesis—diatactic unions occur with different discharge—producing movements, and such may produce some vague thoughts. We infer, then, that the neural action corresponding to the micropsychosis is a form of spontaneous diatactic neural action, not stimulated by the present surroundings, but due to inheritance; it is known only, like all sorts of psychosis, by its subsequent expression. It is inferred that in the infant brain the centres act more or less separately and independently, but that when they act together they may correspond to spontaneous thoughts; when they become controllable through the senses into special combinations, then they are signs of thought and intelligent action. Even later on in the child's life, much of its spontaneous thinking and movement is not controlled by external impressions, but remains entirely spontaneous as micropsychosis and microkinesis.

"It must not be supposed that in micropsychosis every act represents a definite thought, we do not say that every movement is a definite action; special diatactic unions in combinations and series are called thinking, and special combinations and series of movements are called actions. The commencing signs of intelligence are actions following some stimulus, the intelligent character becomes more marked when we find some period of delay—a latent period—between the stimulus and its expression."

The two tables constructed by Warner, to show the comparisons and analogy between micropsychosis and microkinesis in the infant, and the reversion of microkinesis and micropsychosis in adults, will prove of interest to the student.

INFANT.

Micropsychosis.	*Microkinesis.*
There may not be defined thoughts.	There is movement, but no definite actions are performed.
Dreams.	In sleep there are some spontaneous movements.
A child's talk during play is fragmentary.	In play movements are spontaneous.
Early expressions of thought are vocal utterances — *e.g.*, cooing, single words.	Simple acts or gestures feebly maintained.

REVERSION IN ADULTS.

Microkinesis.	*Micropsychosis.*
Post-epileptic action.	Post-epileptic "mental reduction."
Fidgety movements.	Wandering thoughts—inattention.
Movements in restless sleep.	Dreams.
Uncontrolled movements.	Uncontrolled thoughts.
Movements controlled by sight.	Thoughts controlled by sight. Cries of "Mother" during sleep.

All morbid mental manifestations may be traced more or less to factors which may be grouped as follows:—(1) *Internal factors*, under which we group (*a*) the variations or inequalities of the individual's original capacities, and (*b*) the influence of heredity. (2) *External factors*, which include the variations in external circumstances, both physical and social.

We now propose to study somewhat in detail these internal and external factors, and, if possible, to obtain some further insight as to the origin and development of abnormal mentation. So, first of all, we will consider the variations or inequalities of the individual's original capacities.

Original Capacities.—At birth the mind must possess certain simple and fundamental capabilities. To account for their presence at all is exceedingly difficult. A similar amount of difficulty would be found in giving a full exposition of the process of development as a growing adaptation to surroundings. We know that environmental conditions act upon the mind through the medium of the nervous organism, and we are able to trace innumerable modifications in the nervous system which correspond to the growing adaptation to external relations. Were this all, our task would be comparatively easy, and we might seek to explain everything under mechanical causes and effects. The development of the nervous structures, however, is due to more than mere growth and adaptation to external surroundings. The laws of organic development have to be explained in some way other than as mere effects of external conditioning causes; that is to say, the physical organism must possess certain fundamental capacities which determine its adaptation from the very first. Similarly, mental development must start from some inherent state differing in character from any bodily state, and the operation of the mental causes and influences of the development is often only to be estimated by observing those mental laws, facilities, or prohibitions which do not directly depend upon what we know of the physical successions. The absence of normal microkinesis in a fairly-nourished infant is a marked character of the imbecile class; spontaneous movement may, however, be lost temporarily from conditions of lowered nutrition. The mental development is undoubtedly dependent upon the physical development in their ultimate aspects; and, arrest or interference with the latter will arrest or modify the former. Other things being equal, however, the mind possesses within itself certain fundamental attributes, which, so far as we know, cannot be explained in physiological terms, and which manifest themselves throughout the process of development apart from adaptive reactions of the physical organism to any environment. That the mind itself really possesses fundamental intellectual functions of discrimination and assimilation, also primary capacities of feeling and willing, which manifest themselves out of all proportion to any apparent physical development, is evidenced over and over again in the moulding of Genius.

Herbert Spencer regards the great man as the product of many co-ordinated social influences over which he personally has no control* "along with the whole generation of which he forms a minute part, . . . along with its institutions, language, manners, and its multitudinous arts and appliances, he is a resultant. The genesis of the great man depends upon the long series of complex influences which has produced the race in which he appears and the social state into which that race has slowly grown. . . . Before he can remake his society, his society must make him. All those changes of which he is the proximate initiator have their chief causes in the generation he is descended from."

"The causes of production of great men," says Professor James, "lie in a sphere wholly inaccessible to the social philosopher. He must accept geniuses as data, just as Darwin accepts spontaneous variations. For him, as for Darwin, the only problem is, How does the environment affect them, and how do they affect the environment? Now, I affirm that the relation of the visible environment to the great man is, in the main, exactly what it is to the 'variation' in the Darwinian philosophy. It chiefly adopts or rejects, preserves or destroys—in short, selects him." The determining causes of the great man are, continues James, "molecular, and invisible, and inaccessible, therefore, to direct observation of any kind. . . . The same parents, living in the same environing conditions, may at one birth produce a genius, at the next an idiot or a monster . . . and the more we consider the matter, the more we are forced to believe that two children of the same parents are made to differ from one another by a cause which bears the same remote and infinitesimal proportion to its ultimate effects as the famous pebble on the Rocky Mountain crest, whose angle separates the course of two rain drops, itself bears to the Gulf

* "Principles of Sociology."

of St. Lawrence and to the Pacific Ocean."* Joly agrees with James to a large extent. "The great man," says Joly, "is evidently the culminating point of his race, and all experience shows the unlikelihood of two geniuses following each other in the same family. If, however, by the side of an extraordinary individual, immediately preceding or succeeding him, there should be found a nature resembling his, it appears almost always under a feminine form. Here may be found maintaining for a time, or reviving their lustre, those gifts which the head of the family has brought to perfection and whose fertility at the same time he has exhausted."†

Flourens says, "Genius is the faculty carried to an extreme of seeing and thinking justly. Many roads lead to the truth. The man of genius is he who opens these roads." Galton maintained that "intellectual gifts, of whatever kind, were the attributes of a superior type of humanity; and that, like the physical perfections of the racehorse or the prize-bullock, they were transmissible from one generation to another in the favoured families where they occurred." "It is undoubtedly true," says Maudsley, "that where hereditary taint exists in a family, one member may exhibit considerable genius while another is insane or epileptic; but the fact plainly proves no more than that in both there has been a great natural sensibility of nervous constitution, which, under different outward circumstances or internal conditions, has issued differently in the two cases. Such a condition, moreover, is not characteristic of the highest genius, since anyone possessing it lacks, by reason of his great sensibility, the power of calm, steady, and complete mental assimilation, and must fall short of the highest intellectual development of the truly creative imagination of the greatest poet, and the powerful, almost intuitive ratiocination of the greatest philosopher. His insight may be marvellously subtle in certain cases, but he is not sound and comprehensive. Although it might be said then, by one not caring to be exact, that the genius of an acutely sensitive and subjective poet denoted a morbid condition of nerve element, yet no one, after a moment's calm reflection, would venture to speak of the genius of men like Shakespeare

* Quoted from Nisbet's "Insanity of Genius."

† Henry Joly, quoted from "Insanity of Genius."

and Goethe as arising out of morbid conditions." "The acts of the genius may be novel, but they contain, consciously or unconsciously, well formed design," whereas "the acts of the person who has the evil heritage of an insane temperament are purposeless, irregular, and aim at the satisfaction of no beneficial desire. . . . In both cases there may be an uncommon deviation from the usual course of things; but in the one case there is the full recognition of the existing organisation as the basis of a higher development, in the other there is a capricious rebellion as the initiation of a hopeless discord." "Genius" says Nisbet, "has never been the monopoly of any class or system. It is as likely to manifest itself in the peasant as in the peer."

Lelut, Moreau, Lombroso, Hagen, Radestock, all regarded genius as a *névrose*. Ribot, Locke, Helvetius, Goethe opposed this view. Ribot thinks that genius is rarely transmitted; Galton, on the other hand, believed that genius could be transmitted from one generation to another. "Year by year" says Nisbet, "thousands of young men are turned out by the universities and the higher schools of the country, but very few rise to the level of genius. Such education as is received in his youth by a great man has seldom much to do with the shaping of his career. It was not education that made Shakespeare a poet, Reynolds a painter, or Darwin a naturalist." "Diversity of tastes and aptitudes is shown by boys in the schoolroom long before circumstances influence their lives materially, and if an eminent poet or painter could be found willing to take the command of an army in the field, it is inconceivable that a successful general should, by taking thought, excel in writing poetry, or painting pictures in times of peace. Much is said, again, of the importance of taking pains. But nothing is more certain than the fact that industry alone is not enough to enable the aspirant in any walk of life to become distinguished. Some men toil hard to learn what others acquire by the slightest application. Nay, more, the art of taking pains is, itself, a natural endowment, like a good or a bad memory, and is probably responsible for much of the difference existing between the reckless, scatter-brained ne'er-do-well, who never accomplishes anything, and the steady, persistent worker who, with similar faculties, carves his name indelibly upon his epoch." "To the genius that contrives to assert itself, environment is more or less accident." "The great man assimilates and recasts the material supplied him by his epoch. It is the faculty of utilising existing material that constitutes his genius, and this he cannot be said to owe to his environment. It is something personal to himself; something due to his physical organisation." "Genius is essentially a manifestation of nerve-energy, and the scope of a man's faculties is necessarily determined by a physical organisation over which he has no control." In the preface to the second edition of his work upon "The Insanity of Genius," Nisbet quotes the authority of the late Professor Huxley, who says, "Genius to my mind means innate capacity of any kind above the average mental level. From a biological point of view, I should say that a 'genius' among men stands in the same position as a 'sport' among animals and plants, and is a product of that variability which is the postulate of a selection both natural and artificial. In my apprehension, Darwin's theory proper assumed variation as a fact, and does not attempt to account for it, nor can be called upon to do so. And ever since the subject was first discussed, I have tried to insist upon this upon the general ground that a strong and therefore markedly abnormal variety is, *ipso facto*, not likely to be so well in harmony with existing conditions as the normal standard, which has been brought to be what it is largely by the operation of those conditions. I should think it probable that a large proportion of 'genius sports' are likely to come to grief, physically and socially, and that the intensity of feeling which is one of the conditions of what is commonly called genius, is especially liable to run into the fixed ideas which are at the bottom of so much insanity."

Degeneration and Genius.*—Here it may be appro-

* For an account of genius and its relations to insanity, the student may consult the following works:—Spencer, "Psychology," vol. i. part III., and "Sociology"; James, "Atlantic Monthly," Oct. 1880; Joly, "Psychologie des Grands Hommes," 1883; Nisbet, "Insanity of Genius"; Flourens, "De la Raison du Genie et de la Folie"; Maudsley, "Pathology of Mind"; Lélut, "Du Démon de Socrate"; Moreau, "La Psychologie Morbide"; Lombroso, "Entartung und Genie, Neue Studien," and "Genio e Follia"; Hagen, "Allgemeine Zeitschrift für Psychiatrie," 1877; Badestock, "Genie und Wahnsinn," 1884; Ribot, "L'Hérédité Psychologique," 1887; Galton, "Hereditary

priate to briefly consider some of the interesting relationships between physical and mental development. During the last few years there has been so much vigorous writing upon the subject, that we cannot afford to pass over the main contentions without criticism. We may preface our views on the subject by the following statements :—(1) There are certain fundamental capacities of mind which cannot be demonstrated as the result of ancestral experience ; nor do they necessarily represent acquisitions made in the life history of the race. (2) These capabilities need not necessarily manifest themselves at the early periods of an individual's life ; nor are they entirely dependent upon the environment which acts upon the mind through the nervous structures. (3) The conditionings of such mental developments do not invariably follow what we imagine to be the proper laws of organic and nervous development. (4) Genius, although not invariably associated with, or symptomatic of, a neuropathic process, is, nevertheless, often closely allied to the neuropathic diathesis, as evidenced in the histories of past and present geniuses. (5) So far from being the result of progressive achievements of the intellect are some forms of genius, that they may more truly be classed with the degenerate than with the healthy.

Now let us review some of the examples given of the "degenerate" genius, and form our own conclusions as to the validity of the arguments given by the strenuous advocates of the degeneration theory. We are told that Molière, Petrarch, Flaubert, Charles V., Handel, St. Paul, Peter the Great, and Dostoieffsky were epileptics ; Paganini, Mozart, Schiller, Alfieri, Pascal, Richelieu, Newton, and Swift were the victims of diseases epileptoid in character ; Lenan, Montesquieu, Buffon, Dr. Johnson, Santeuil, Crébillon, Lombardini, Thomas Campbell, Carducci, Napoleon, and Socrates suffered from spasmodic and choreic movements ; Zeno, Cleanthes, Dionysus, Lucan, Stilpo, Chatterton, Blount, Haydon, Clive, &c., committed suicide ; Coleridge, James Thomson, Carew, Sheridan, Steele, Addison,

Genius"; Lewes, "Fortnightly Review," Feb., 1872 ; Beneke, "Erziehungslere," i. p. 101 ; Pfisterer, "Pædagogische Psychologie," § 2 ; Weir, "Genius and Degeneration" ; Dallemagne, "Dégénerés et Desequibrés," Paris, 1895 ; Nordau, "Degeneration," 1895, Leipzig, 1894 ; Hirsch, "Genie und Entartung, eine Psychologische Studie," Leipzig, 1894.

Hoffman, Charles Lamb, Madame De Staël, Burns, Alfred De Musset, Kleist, Caracci, Ian Steen, Morland, Turner, Gérard De Nerval, Hartley Coleridge, Dussek, Handel, Glück, Praga, Rovani, and the poet Somerville abused the use of alcohol and opium; Sallust, Seneca, and Bacon were suspected felons; Rousseau, Byron, Foscolo, and Caresa were grossly immoral; Murat, Rousseau, Wagner, Clement, Diderot, and Praga were sexual perverts. Lombroso says :—" I have been able to observe men of genius when they had scarcely reached the age of puberty. They did not manifest the deep aversions of moral insanity, but I have noted among all a strange apathy for everything which does not concern them, as though, plunged in the hypnotic condition, they did not perceive the troubles of others, or even the most pressing needs of those who were dearest to them. If they observed them, they grew tender and at once hastened to attend them; but it was a fire of straw, soon extinguished, and it gave place to indifference and weariness."

The following list of men of genius has been taken from Lombroso's work :—Carlo Dolce, painter, *religious monomania;* Bacon, philosopher, *megalomania, moral anæsthesia;* Balzac, writer, *marked epilepsy, megalomania;* Cæsar, soldier, writer, *epilepsy;* Beethoven, musician, *amnesia, melancholia;* Cowper, writer, *melancholia;* Chateaubriand, writer, *chorea;* Alexander the Great, soldier, *alcoholism;* Molière, dramatist, *epilepsy;* Charles Lamb, writer, *alcoholism, acute mania, melancholia;* Mozart, musician, *epilepsy, hallucinations;* Heine, writer, *melancholia, spinal disease;* Dr. Johnson, writer, *chorea;* Malibran, *epilepsy;* Newton, philosopher, *amnesia;* Cavour, statesman, philosopher, *suicidal impulse;* Ampère, mathematician, *amnesia;* Thomas Campbell, writer, *chorea;* Blake, painter, *hallucinations;* Chopin, musician, *melancholia;* Coleridge, writer, *alcoholism, morphinism;* Donizetti, musician, *moral anæsthesia;* Lenau, writer, *melancholia;* Mahomet, theologian, *epilepsy;* Manzoni, statesman, *folie du doute;* Haller, writer, *hallucinations;* Dupuytren, surgeon, *suicidal impulse;* Paganini, musician, *epilepsy;* Handel, musician, *epilepsy;* Schiller, writer, *epilepsy;* Richelieu, statesman, *epilepsy;* Praga, writer, *alcoholism;* Tasso, writer, *alcoholism, melancholia;* Savonarola, theologian, *hallucinations;* Luther, theologian, *hallucinations;* Schopenhauer, philosopher, *melancholia, omniphobia;* Gogol, writer, *melancholia, tabes dorsalis;* Lazaretti, theologian, *hallucinations;* Mallarmé, writer, *suicidal impulse;* Dostoieffsky, writer, *epilepsy;* Napoleon, soldier, statesman, *folie du doute, pseudo-epilepsy;* Comte, philosopher, *hallucinations;* Pascal, philosopher, *epilepsy;* Poushkin, writer, *megalomania;* Renan, philosopher, *folie du doute;* Swift, writer, *paresis;* Socrates, philosopher, *chorea;* Schumann, musician, *paresis;* Shelley, writer, *hallucinations;* Bunyan, writer, *hallucinations;* Swedenborg, theologian, *hallucinations;* Loyola, theologian, *hallucinations;* J. S. Mill, writer, *suicidal impulse;* Linnæus, botanist, *paresis.*

With such a formidable array of evidences one is apt to gain bias in favour of the "degenerate" theory, and to class genius with the neurasthenic, hysteric, and epileptic types of dissolution. The notion of *balance* as the test of mental health would serve to rid us of many of the difficulties in estimating the degenerate characteristics of genius. In former chapters we have emphasised the law, that with the evolution of the particular there is a corresponding dissolution of the general. Many of the so-called geniuses are merely instances of a progressive evolution of the particular at the expense of the general. They have devoted their attention to the development of one faculty to the neglect of the others. The individual who possesses a versatile mind, and an aptitude to deal with all conditions of his environment, may be said to have a well-balanced mind. Directly, however, he seeks to cultivate one faculty in excess of the others, evolution of the particular faculty, and dissolution of the other faculties begin. Many geniuses might more truly be described as men with a special aptitude in one direction, or as men whose general ability has given way to the development of a special ability. There is a vast difference between a genius proper, or even a very clever man, and a man who exhibits an unusual aptitude or cleverness in some limited direction. Some of Lombroso's "borderland" cases of calculating geniuses, thought readers, artists, political and religious "mattoids," are, however, scarcely to be accounted for in this way: in fact, they seem rather to fall within the domain of the abnormal as exhibiting symptomatic effects of degenerative processes.

Hirsch has pointed out in clear language that genius is a sociological, not a psychological concept. Poets, musical composers, musical executants, actors, painters, men of science, statesmen, soldiers, and devotees, when geniuses, seem at first sight to have nothing in common except rarity and originality. The unusual and the extraordinary often arrest our attention. Thus it is, that the fertility of novel ideas in some of the so-called geniuses, which somewhat resembles involuntary maniacal raving, often serves to build a reputation.

Again, the fact that hallucinations are exceedingly common in insane people is no argument that they are necessarily insane symptoms. On the contrary, hallucinations may be perfectly compatible with sanity. Again, who shall define the limits of interpretation of what appears to the mind? The materialist assumes the existence of a molecular causation to account for the origin of all objects of perception; whereas the spiritualist believes in spiritual factors. Who shall decide upon such a point, and prove the sanity or insanity of these combatants? Until we are able to solve these ultimate problems, we must, as presumably sane individuals, be generous in the limits we assign to the interpretations which others give to their own experiences.

Unfortunately, many writers upon the pathological aspects of genius attempt to define mental health from its purely objective standpoint. They make of it an objective description, and not a subjective appreciation. The objective manifestations of the sensibilities, aims, beliefs, and characteristics of others, they regard from their own subjective standpoint. Their own functions, which they regard as sound, are compared with the objective manifestations of others, and any departure from their own standpoint is regarded as psychopathic, and therefore not to be tolerated.

Were we to resort to the *argumentum ad hominem* we might say, that these advocates of degeneracy are in reality degenerate advocates. They themselves adopt that weapon of rhetoricians and demagogues, the *argumentum ad populum*, in that they address themselves to the masses at large, and seek to excite their feelings by arrogant and insulting biographical details, which tend to prevent the formation of a dispassionate judgment upon the matter in hand. Max Nordau might, from his writings, be described as a degenerate. He is not, however, an example of the genius who is degenerate, but of the gifted man who suffers from auto-hypnotism, and who appears to exhibit a condition of monoideism, which has been developed at the expense of his sense of justice and practical reason. We agree with Professor James, who believes that the real lesson of the genius-books is, that we should welcome susceptibilities, impulses, and obsessions if we have them, so long as by their means the field of our experience grows deeper, and we contribute the better to the race's stores; that we should broaden our notion of health instead of narrowing it; that we should regard no single element of weakness as fatal—in short, that we should not be afraid of life.

It must be remembered that the pursuit of a natural bent is not infrequently attended by pre-occupation, sleeplessness, nervous exhaustion, constipation, dyspepsia, and other effects determined by close and sedentary work. Hence, many of the affections described as being coincidental with the efforts of genius are in reality mainly caused by the efforts themselves. Again, various bodily infirmities or diseases may be determining factors in favouring the pursuit of a hobby, be it scientific or otherwise. Thus, for instance, the cripple, unable to use his limbs, may give more time to the cultivation of his mind. The blind man cultivates his ear for music, and so on.

The investigation as to the percentage of geniuses who have psychopathic traits has never been accurately carried out. We do not know whether the percentage of diseases is higher in the geniuses than in the population. Nisbet* found, that out of 250 men of genius, all died of some nerve disorder. But, inasmuch as he appears to include under nerve disorders such affections as phthisis, pneumonia, heart disease, scrofula, rheumatism, syncope, diabetes, gout, and stone, etc. etc., his conclusions are not very satisfactory. We can imagine that a genius is as liable to disease as ordinary persons, and, of course, the genius must die of something.

Much of the farcical writing upon the subject of genius we believe to be due to (1) want of true breadth of culture—*i.e.*,

* "The Insanity of Genius," 1893, p. 315.

a sympathy with, art pursuits, literature, and religion, derived from something more than a superficial examination of the evidences thereof; (2) the difficulty of forming an opinion of the general question from any one standpoint, and under the light of any one set of traditions; (3) the fact that the causes and sources which are most vital can often only with reluctance be disclosed to a nerveless and unsympathetic public opinion; (4) materialistic bias, and the consequent lack of healthy sociological determination of the will, seeing that the belief in the supernatural has always been almost universal.

Inherited Dispositions.—When we speak of inherited dispositions we mean, that some mental tendency, or disposition to think, feel, or act in some particular way is the result of a transmitted tendency gained by ancestral experience, and that it represents some mental attribute gained in the course of the history of the race. The points upon which evolutionists endeavour to assert themselves are:—(1) The psychical development of the individual is mainly conditioned by that of the race—*i,e.*, owing to the principle of hereditary transmission, the nerve-centres and the corresponding psychical activities tend to unfold in the individual in the order in which they have been developed in the history of the race; (2) in the evolution or progressive development of the race any improvement of faculty or capability tends to transmit itself as a fundamental capacity or inherited disposition.

Since Lamarck published his views, there has been an almost constant discussion about the laws of heredity. Cuvier and St. Hilaire discussed the question in 1830. Darwin, Wallace, and Huxley have since revived the debate in England, whilst Haeckel has discussed the matter in Germany. The present discussion between Spencer and Weismann began in 1883, when Weismann first challenged the principle of inheritance of acquired characters as a factor of evolution.

In any theory of development and heredity we must take into account the facts of embryology; and firstly, we have to note, that new individuals arise, not from all parts of the body, but from the more or less isolated germinal cells. These cells are apparently isolated during the whole of the life of an individual, and yet, if they are to contain the whole store of heredity, they must have some connection with the bodily and mental activities of the individual. Were this otherwise it would be difficult to account for the transmission of acquired characters through successive generations. On this subject of the connections between the germinal cells and the individual we have only very scanty knowledge. Retzius investigated the nerve-endings in the regions of the germinal cells, but he found that nerve-fibrillæ were scanty rather than plentiful. It is difficult, therefore, to imagine how the potential activities of the germinal cells are derived through the medium of the nervous system. And yet, we cannot but believe that the germinal substance does contain certain specific characters which manifest themselves in the offspring.

Spencer* and Weismann† have been at issue as to the adequacy of natural selection in the process of evolution. Spencer believes that the reactions of the individual to his environment is by transmission, and that this is the main factor of evolution. Weismann, on the other hand, contends that evolution depends exclusively upon the survival of fortuitous favourable variations. To attempt to decide the issue would be presumption on our part. We can only accept the evidences of both sides as inconclusive. From a theoretical point of view, the arguments of both combatants would appear to contain much that is plausible; but we have yet to see how the theories will stand the test of the exact methods of science and induction. In any case, we have yet to clear up the obscurity as to the relation between the nervous system and the hereditary germinal substance.

The transmission of normal traits is a wide subject, and in this work we shall have chiefly to deal with the transmission of abnormal or diseased modes of thought. Much stress is laid upon the hereditary factors in insanity; but there is still much confusion and inaccuracy as to their relative importance and frequency. Thus, the confusion may arise through imperfect conception as to what constitutes an hereditary predisposition—

* "The Inadequacy of 'Natural Selection,'" a rejoinder to Professor Weismann—"Contemporary Review," Feb., March, May, and Dec., 1893.

† "The All-Sufficiency of Natural Selection"—"Contemporary Review," Aug. and Sept., 1893.

i.e., the notion as to the neurotic factors in the ancestry may be too narrow; or, on the other hand, the notion may be too wide, and include hereditary factors which are of little practical significance.

With regard to these causes of confusion we have to note the tendency to omit the consideration of many of the so-called functional nervous disorders in the parents. Thus, for example, a history of instability, hysteria, epilepsy, chorea, somnambulism, etc., in the parents is not infrequently overlooked. Again, most people know no other members of their ancestry than their father and their mother, and many do not even know them; and even though a patient may know much about one or both of his parents, he very commonly knows little or nothing about their diseases. When you go farther back into his genealogy, and recollect that every individual has four grandparents, from any one of whom he may inherit a disposition or tendency to disease, how little does he know of the condition of the health of any of these grandparents beyond the disease, possibly, of which they died? If we transfer our observation to the third line of ancestry only, and reflect that there are eight great grandparents to every individual, we get into a haze of ignorance and confusion, out of which it is well-nigh impossible to extricate ourselves. Every individual must die sooner or later of something, and a physiological decay without evidence of disease is a rarity. In short, unless careful, we are apt to attach undue importance to family histories, and more especially perhaps where the members affected are remote from the individual in question. At the same time, there can be no doubt, that many hereditary tendencies are transmitted from grandparents and even great grandparents, nearly as readily as from the parents themselves; and sometimes from a comparatively remote ancestry you will find the mental peculiarities, the same dispositions, and the same tendencies transmitted, with astonishing precision of reproduction.

Speaking generally, the offspring tends to inherit the characteristics of both parents. In some instances, however, there may be a preponderance of the characteristics of one or other parent; or there may be a combination of some of the parents' qualities, which manifest themselves coincidently or alternately during the lifetime of the offspring. The inherited disposition of the offspring, therefore, depends upon the constitution of the germ and sperm. Defects in the germ or sperm may consist in abnormality of structure, or energy, or both. Physically, there may be stunted growth or deformity; mentally, there may be defective intellect or other mental abnormality. Most idiots are not only defective in stature and mental power, but also in vital energy. Some possess great bodily vigour, and attain to an advanced age. This, according to Mercier, is because in them the idiocy, the premature arrest of the development of the brain, does not arise from failure of the developmental impetus in consequence of its own inherent weakness, but from violent arrest due to some influence acting from without, to violence to the head at or after birth, to inflammation of the meninges in early life, to the effect of exanthemata or other external action.

Intermarriages also intensify family traits. The ill effects which result from the marriage of first cousins may be attributed to the heritage of a neurosis from a near ancestor, either from the common or the separate families. When there is no inheritance in the common family, but near inheritance in one only of the separate families, the kinship alone is held to be no bar to marriage. This, however, is an opinion which might prove dangerous if accepted without due consideration as to the nature of the near inheritance. The safer course would appear to be, to disapprove of the marriage of cousins when there is a near inheritance of insanity on either side.

Too great similarity or dissimilarity between parents is apt to influence the development of the offspring. The conditions which render the germ and sperm unsuitable to each other are, however, but little known. The practical points we have to remember are: (1) an individual may develop or acquire a neurosis which affects his own life, or the life history of his family; (2) the neurosis may increase or diminish in strength from generation to generation, or it may skip a generation; (3) the neurosis may appear at a later period of life in the offspring than in the ancestors; (4) the forms of the neurosis may alternate in the life history of the individual, or in that of the family; (5) the type of neurosis may be determined by one or other parent, with or without transmission of identical tendencies; (6) the inheritance of a slight neurosis connotes a ready break-down, but rapid recovery; a strong neurotic tendency, on the other hand, connotes either early and complete breakdown or perpetual instability; (7) an inherited neurosis often manifests itself as epilepsy; comparatively infrequently in general paralysis.

Revington believes, that some cases point strongly to the theory, that while both hereditary and acquired neuroses, if strong, tend to the development of general paralysis at an early age, the tendency of the former is to protract, and that of the latter to shorten the duration of the disease. The offspring of general paralytics are liable to suffer from all sorts of neuroses, and more especially epilepsy. Of the other factors which tend to produce hereditary neurosis we would have to take into account consumption, gout, rheumatism, syphilis, paralysis, alcoholism, spasmodic asthma, diabetes, all of which may be coincidental, or they may be one of the links which will, in the future, be found to connect so-called functional potentialities with organic realities.

Phthisis, according to Van der Kolk* and Guislain,† is in direct relationship with insanity, and it is frequently seen in the descendants of the insane, and in their progenitors. Thompson ‡ shows that the heredity in the two diseases is similar in the following respects—viz., (1) Transmission is from either parent; (2) the disease may appear in the child before it is developed in the parent; (3) the disease may be transmitted by the parent without development; (4) atavism is a frequent and important characteristic. Clouston believes that a simple phthisical heredity is not so dangerous in leading to insanity, as a hereditary legacy of insanity is in leading to phthisis.

Scrofula.—Ireland § says of the association of scrofula with idiocy and imbecility, "Perhaps two-thirds or even more are of the scrofulous constitution." Any one who has worked amongst

* "Mental Diseases."
† "Leçons orales sur les Phrenopathies," 2nd edit., by Engels.
‡ "Phthisical Insanity"—"Tuke's Dictionary," p. 939.
§ "Idiocy and Imbecility."

idiots and imbeciles cannot have failed to note how important a rôle is played by the strumous diathesis.

Gout is supposed by some to be a determining factor in the production of an hereditary neurosis.

Rheumatism is also supposed to start a diathetic condition which may predispose to neuroses.

Syphilis.—Clifford Allbutt, writing upon mental affections in children, says, "Apart from traumatism, sunstroke, poisons, malformation, and the sequelæ of typhoid and other fevers, etc., insanity in children is practically always hereditary; though bad bringing up and excessive study may largely conspire with original tendency to produce it. If, in such a case, the parents are not actually insane, eccentric or dissipated, we shall find that syphilitic antecedents may have been the cause of insanity in the offspring, or the father may have been well advanced in years, if not himself also of failing vigour, at the time of procreation." Drs. Langdon Down, Shuttleworth, Fletcher Beach, and others have described evidences of congenital syphilis in idiots and imbeciles. Savage believes, that "congenital syphilis causes death from convulsions and from other diseases in children, who would probably have been mentally defective had they lived, and that many minor nervous disorders occur in such children who are managed at home because they are physically weak, and that these lesser neuroses are seen by out-patient physicians in many patients who die before maturity."

The cases of mental defect or disorder in connection with congenital syphilis have been classified by Savage under three heads, viz.:—

"1. Those with general defect of development, with moral and intellectual want; the only special feature being a distinct history of parental syphilis with evidences of the disease in the patient. Such children may have fairly well formed heads, but who after early infancy have not developed; they have learned to walk, but not to talk, and are restless and mischievous, and only to a very small degree educable. They require to be removed from home for the sake of the other children and for special training.

"2. Those with sensory defect and consequent mental want. This group contains cases in which specific inflammation has caused deafness or blindness, or both, in early infancy; these defects leading to idiocy by deprivation of sensory stimulation. In some of these cases special education for deaf and dumb and blind fails to develop any really useful mind, and with the growth of sexual desire much serious trouble may arise, and the small mental gain effected may be ruined very rapidly. The probable end of these cases is the early death from some physical disease, such as phthisis.

"3. Those with epilepsy or paralysis, and consequent epileptic or paralytic idiocy. (*a*) The *epileptic* varieties frequently begin with convulsive seizures in early infancy, and these fits recurring, become habitual and prevent mental development. In some cases the fits cease at some period of life, say about seven or fourteen years of age, but, as a rule, the mind has been too seriously damaged to recover, and the patient remains a quiet non-epileptic idiot. (*b*) In the *paralytic* cases, as also in some epileptic ones, local lesions about the cranium, the membranes, and the brain itself are the cause of the convulsive or paralytic symptoms. As a rule, these paralytic idiots are hopelessly weak, and need asylum care, and they usually live but a short time. In a few cases the general symptoms of congenital syphilis only affect the mind later. Thus, defect of sight and hearing may act in the same way that disfigurement did in making the patient morbidly solitary, self-conscious, and suspicious; in the end becoming deluded and insane. These cases generally are met with in young women, and the prospect of cure is very slight, most of the patients passing into chronic weakmindedness or delusional insanity."

To these we might also add a fourth group of great interest, of which the symptoms may be due to inherited syphilis, though the evidence is as yet unsatisfactory. These cases present a remarkable resemblance to general paralysis. The salient features of some of them are slow but progressive dementia, with concomitant steady development of generalised paralysis and great emaciation. This malady has been fully recognised by Wiglesworth, Clouston, Shuttleworth, and others, and the writer has seen several cases which answer to this description. Whether they are true cases of early general paralysis is still doubtful, and their pathology is undetermined.

Intemperance.—The consequences of alcoholism on the part of the parents are, not only impairment of their own mental faculties, but also in the offspring a tendency to drink, epilepsy, insanity, nerve diseases, idiocy or imbecility, and in a word, extinction of the race. From the social point of view, there is an increase of mortality, diminution of the number of births, decrease of moral energy, and of the rate of development of intelligence; in fact, there is weakening of the vital and intellectual energies of the race. Legrain believes that the great majority of drinkers are predisposed by heredity, and that the craving for strong drink is transferred from father to son, and in many cases in an aggravated form. Undoubtedly, many of the cases of alcoholic insanity, are individuals who have a neuropathic diathesis, and who are predisposed to be more readily affected by the influence of alcohol.

A predisposition to alcohol shows itself in several ways—*e.g.*, (*a*) Alcoholic symptoms appear more readily; (*b*) there is a tendency to drink at an earlier age; (*c*) the mental condition during drunkenness often reveals the inheritance of ideas or tendencies, which normally were kept in subjection; (*d*) the mental symptoms are often characterised by impulsiveness, and tendencies to commit rash acts; (*e*) delirium tremens, transitory mania, and even epileptiform convulsions manifest themselves as symptomatic of a predisposition; (*f*) in addition to susceptibility to alcohol, mental perversions may be caused suddenly by exciting causes in which alcohol plays no immediate part; (*g*) alcohol may determine a psychosis which is inherited; (*h*) the predisposed individual tends more to misinterpret his sensory impressions; (*i*) the mental states or ideas are changeable, and constantly interrupted by lucid intervals; (*j*) the melancholic symptoms are somewhat different, and suicidal tendencies are thought by some authors to be an indication of a special predisposition.

Legrain* gives four varieties of the special predisposition to suicide in these cases—viz., (1) Instead of having the form of genuine alcoholic suicide (an accidental act, or caused by fright in consequence of special hallucinations), the tendency is logically connected with the melancholic ideas as expressed by the patient; (2) sometimes those who relapse into delirium tremens attempt suicide at each attack; (3) in the course of one and the same attack of delirium tremens, several attempts may be made; (4) in the ancestors of drinkers who become melancholiacs and commit suicide during an act of delirium tremens, a special predisposition to melancholia exists.

In a predisposed individual, it is not uncommon to meet with maniacal conditions of an ambitious or an exalted kind.

* "Tuke's Dictionary," p. 71.

In an attack of delirium tremens in a person predisposed, the delirium lasts longer and is more apt to be followed by another psychosis, than in the case of one who has not the predisposition.

Diabetes.—The frequency of the occurrence of diabetes in the parents or near ancestors of insane patients is noteworthy. Savage believes that its occurrence is chiefly among the affluent classes. Whether there is any direct relationship between insanity and diabetes, we are as yet unable to say. From the records of Bethlem Hospital it would appear, that most of the cases with a family history of diabetes have been of the melancholic or hypochondriacal type. This confirms the observations of Savage, who also noted that the periods of adolescence and the climacterium were especially prone to favour the occurrence of neuroses in such cases. Other morbid factors, which tend to determine the life-histories of a family, might be mentioned; but the scope of this work will not allow us to do justice to the innumerable investigations that have been made. We must, however, note one or two of the main functional and organic diseases of the nervous system, which appear to be the result of ancestral taint, and which alternate or interchange in the life-history of the individual or of the race.

There are some inherited neurotic tendencies which do not become manifest unless the individual is subjected to exciting causes. Such individuals are excitable, eccentric, very susceptible to shock, passionate, and easily affected by alcohol or by injury to the head. Others are affected by migraine, neuralgia, headaches, sensory epilepsy, spasmodic asthma, neurasthenia, and other neurotic manifestations. The various forms of mental disease in the adult may be, in great part, due to neurotic inheritance. General paralysis may be in part due to inheritance, but it is more common for the offspring of general paralytics to be neurotic.

There are other forms of inherited neuroses which are apt to develop in the life history of the individual. Chorea, hysteria, and some forms of epilepsy, may develop into grave forms of mental disturbance. Sometimes a strong neurotic inheritance develops early in the life of the individual, and manifests itself in the graver forms of epilepsy, moral insanity, or criminality. In infancy a strong inheritance may show itself in convulsions, epilepsy, hydrocephalus, imbecility, or idiocy.*

External Factors in Development. — *Social Environment.* — That the social environment of which we are members may influence our minds through the media of our sense-impressions, there can be no possibility of a doubt. Not only are we influenced morally and intellectually by our social surroundings, but our mental development would be but rudimentary without them. As we advance in life these social influences gradually increase in complexity. That they are essential to the mental development of the ordinary individual is manifest; but, as already pointed out, they are not everything to the manifestations of genius.

The influences of society upon an individual may be exerted in a natural way—*i.e.*, the individual adopts the prevailing tone of thought of his family and immediate acquaintances. It is impossible to extend our range of view so as to include all that belongs to social life; nor can we attempt to consider all the implications of moral life, nor how moral law influences social life, organisation, and government. A philosophy of moral life would have to include the whole range of social questions. Just as the unity of a family is founded on biological and ethical laws conjointly, so all the relative duties of the social life conform to those universal laws which exist in accordance with the bonds of nature.

Here we have only to consider how members of a society may combine to predispose the generation of a morbid psychosis. In the struggle for existence the stronger often carries off the prey from the weaker. In the building up of character in man and of mankind generally, there is an enlargement of the evolutional activity, a finer elaboration of the moral and intellectual contents of consciousness, and the executive effectiveness

* See Revington, "Neuropathic Diathesis," Journ. Ment. Science, April and July, 1888; Mercier, "Sanity and Insanity," also "Heredity"—"Tuke's Dict."; Thomson, "Hereditary Nature of Crime," Journ. Ment. Science, vol. xv. p. 487; Spencer, "Principles of Biology," Part II. chap. viii.; Dunlop, "Illustrations of Heredity," Journ. Ment. Science, vol. xxvii. pp. 39, 131; Dexter, "Heredity," *ibid.*, vol. xxii. p. 152; Compayrè, "Heredity in Children," *ibid.* vol. xxvii. p. 29.

of volition is progressively acquired. At any period of our habituated cerebration, contrarieties of motive may affect the *ego* and germinal power of self-determination, and, by persuasion, cause the *ego* to decide arbitrarily, by fresh importations of energy, options which are significant of deterioration or dissolution.

The whole history of the world is covered by the shadows of beliefs, germinated endemically and in ignorance. Social requirements and traditions have given rise to the most diverse religions, views, and modes of life. It is susceptible of proof that, with the increase of refinement, the occurrence of nervous and mental disorders has increased in a proportion which has been maintained to the present day; and, inasmuch as this subject is of great importance to the community, we must devote some time to its consideration.

Psychopathic Epidemics.—Many of the narratives recorded in the Old Testament, and some of the δαιμονίζομενοι in the New, are ascribed by some authors to madness. Greek mythology, in the stories of Hercules, Ajax, Orestes, Athanias, and Alcmæon, touches on these phenomena and on lycanthropy, and the madness of the daughters of Prœtus, and the uterine disease of the Lythians are even quoted as examples of epidemical psychopathies.* We have examples of many psychical anomalies from the work of Galen.† The monomania of the Silesian maidens,‡ and the feverish psychical excitement of the inhabitants of Abdera, after witnessing the performances of the Andromache of Euripides, are adduced as being in some degree instances of an epidemic psychopathy. Many of these accounts of the ancients are, however, hardly germane to the inquiries of the alienist or the philosopher. And then again, the undefined word *madness* used in reference to religious matters is often misleading.

All ages seem to have been characterised by absurd fables and exaggerated speculative conceptions. Ever, in the history of the world, new and mighty movements have agitated all nations, awakening men from their dream of permanent repose, and convulsed the whole or parts of the civilised world.

* Frieder, "Litt. Gesch.," 17 etc.
† "Diseases of the Mind."
‡ "Plutarch de Virtut. Mulierum."

In the middle ages destructive epidemics, for the most part advancing from east to west, visited the whole of the known earth; characterised during the earlier periods of this epoch, rather by cutaneous affections, and during the later, by affections of the abdominal organs and sensori-motor system.* Of the latter we may specially notice the dancing mania (pilgrimage mania),† which first appeared about the year 1212. Thousands of young people, mostly approaching the age of puberty—*i.e.*, from twelve to eighteen—assembled together, and formed what were called "children's pilgrimages." They proceeded (1237) till they sank exhausted to the ground, so that many died, and the survivors were afflicted with tremors which continued as long as they lived. This disorder seized boys and girls suddenly, and, together with other phenomena, was combined with a morbid antipathy to red colours and to weeping; and, when the disease was at its height, tympanic swellings of the abdomen ensued, and paroxysms of howling, screaming, leaping, and an excessive love of dancing set in.

In the time of Paracelsus the form of this disorder was milder, and approached that of St. Vitus's Dance. Häser compares this epidemic with the *lycanthropy* of the ancients. However hypothetical any notion may be, which we are able to form as to the nature of this disorder, a psychical momentum was certainly in operation,‡ and a very able writer § treats even the Crusades as an epidemic of mental disease. At the beginning of the eighth century *raphania*, which often commenced with mania and terminated in imbecility, became particularly prevalent. Webster speaks of an epidemic madness which prevailed in England in 1354, which attacked the lower classes, and subsequently spread through France and Italy. "During periods of plague," he adds, as if by way of explanation, "some general influenza appears to have seized the brain, even of persons who were not attacked by the plague itself." Since the middle of the eighteenth century neurotic storms in social life have become more and more developed.‖ Un-

* Häser, "Geschicte der Epidemischen Krankheiten."

† Hecker, "Die Tanzwuth."

‡ Feuchtersleben, "Med. Psych.," p. 42.

§ Wawruch, "De Morb. Pop.," (MS).

‖ Leupholdt, "Gesch. d. Ges. n. Krankh." 136.

doubtedly all ages have been characterised by absurd beliefs and speculations; and the mental epidemics of the days of old are thought by some writers to have their equivalent in the mental rhapsodies of the present day, as shown in almost incredible psychical deviations and beliefs in the fantastic and unreal.

The mystical aberrations of primitive people, were, in their universality, no more within the actual borderland of true psychopathy, than many superstitious beliefs and traditions of the present age. The endemic beliefs, with their histories and endless variations, however, do not form part of our subject; so we propose to deal more particularly with those morbid manifestations which have passed the borderland of sanity, and in their nature and violence have appeared as clearly marked epidemic psychopathies.

Considered *seriatim*, the various psychopathies may be described, as they have been characterised, as purely mental or moral perversions, or as physical aberrations secondary to the physical contagion.

Of the sensory type, the world has witnessed many curious illustrations. The spectral illusion occurring on the banks of the Clyde (1686) affected a great many persons who saw, while others failed to see, companies of men in arms marching along and disappearing. They also saw bonnets, guns, and swords. In this instance, emotional predisposition doubtless favoured production. There is a striking observation made by Theresa, whom M. Maury characterises as the metaphysician of feminine mysticism and of ecstatic illumination—namely, "I have known some of weak mind who imagine they see all that they think; and this," she adds, "is a very dangerous condition." Many writers believe, that whatever mental or bodily state can be excited through the senses from without, may also arise from within from imagination proper. It is this principle which continually turns up in the consideration of the questions now engaging our attention, and which would seem to enable some psychologists to form a successful clue to many otherwise inexplicable sensory manifestations. We have already seen that, whatever the cause may be, in some conditions of the brain, the sensory centres may be so powerfully excited that the effect is identical in sensory force (in objectivity) with that which results from an impression produced upon the peripheral terminations of the nerves, causing hallucinations or phantasmata. The mind, under certain circumstances, can, by attention, recall the sensorial impression so distinctly, as to produce (*e.g.*, in the case of sight) the spectrum or image which was impressed on the retina and perceived by the sensorium.* It cannot be denied, however, that there are sensorial phenomena, whose origin, at any rate at present, cannot be explained by an exercise of the imagination process, as such, either voluntary, normal, or unduly stimulated.

Yet many of the astonishing psychological dramas which have at various epochs arrested the attention of the world, have arisen through phenomena allied to the products of the imagination and propagated by imitation.† At the present day we look back with a degree of wonder at the belief in witchcraft, which may be said to have formed an article of religious faith in every European country throughout the sixteenth and seventeenth centuries. A notion was universally entertained, that the devil and some subordinate evil spirits, in pursuance of their malevolent ends, went about, sometimes in visible shape, seducing poor human nature. Such "trafficking with the powers of darkness," as it was technically called, was witchcraft, and, according both to the letter of Scripture and of civil law, was a crime punishable with death.

Originating in ignorance, together with a love of the marvellous and from many religious misconceptions, the belief in witchcraft may be traced through the early ages of Christianity; but the modern prevalence of the delusion may be said to date from the promulgation of an edict of Pope Innocent VIII., in 1484, declaring witchcraft to be a crime punishable with death. Like all popular manias, the witchcraft delusion had its paroxysms. It followed the well-known law of supply and

* Hack Tuke, Body and "Mind," p. 80, vol. i.

† Due to imagination, understood in the sense of expectation, we have, as examples, the Okeys, the Wizards of Kamschatka, the Whirling Dervishes of India, the Second Sight Men of the Highlands, the Serpent Eaters of Egypt, and the Wise Men and Prophets who may still be found in Yorkshire, all knowing how to excite convulsions, or delirium, or spectral illusion and somnambulism in themselves or their dupes, by mental acts or drugs.

demand, and the frenzy never lacked victims. As soon as witches were in request they made their appearance. The folly while it lasted was complete, and received the solemn sanction of people of every quality and profession.

It is a curious law of human nature, of which we have seen many modern illustrations, that even crimes, real or imputed, when they excite much public attention, tend to produce repetitions of themselves. In this way, such offences sometimes assume a character approaching that of epidemical diseases. In 1515, during the space of three months, 500 witches were burned in Geneva; in a single year, in the diocese of Como, in the north of Italy, 1,000 were executed; and it is related, that altogether more than 100,000 individuals perished in Germany before the general mania terminated.

In France, the belief in witchcraft led to a remarkable variety of superstition, known in French law as *lycanthropy*, or the metempsychosis of a witch into a wolf.

In the reign of Henry VIII., 1541, Elizabeth, 1562, and also of James I., witchcraft, though always penal, then became of itself a *capital* crime. James I. passed an act in the first year of his reign, which, on account of its degree of minuteness, is almost unprecedented. He defined witchcraft distinctly, and enacted that, "Any one that shall use, practise, or exercise any invocation of any evil or wicked spirit, or consult or covenant with, entertain or employ, feed or reward any evil or wicked spirit, *to be for any purpose*, or take up any dead man, etc. etc. etc.; such offenders, duly convicted and attainted, shall suffer death." Many years had not passed away after the passing of this statute, ere the delusion, which had theretofore caused but occasional and local mischief, became an epidemical frenzy, affecting every corner of England.

The revolting crimes of the monster, Matthew Hopkins, who, with his assistants, moved from place to place in the regular and authorised pursuit of his trade of witch-finding, will give an example of the horrible fruits of the witchcraft frenzy in general. From each town he visited, Hopkins exacted the stated fee of twenty shillings; and in consideration thereof, he cleared the locality of all suspected persons, bringing them to confession and the stake in the following manner:—

He stripped them naked, shaved them, and thrust pins into their bodies, to discover the witch's mark; he wrapped them in sheets, with great toes and thumbs tied together, and dragged them through ponds and rivers, when, if they sunk, it was held as a sign that the baptismal element did not reject them, and they were cleared; but if they floated, as they usually would do for a time, they were then set down as guilty, and doomed. In short, such abominable cruelties were practised upon the accused, that they were glad to escape by confession. After he had murdered hundreds, however, the tide of popular opinion was turned against him, and he was subjected by a party of indignant experimenters to his own favourite test of swimming. It is said he escaped with his life, but from that time forth he was never heard of again.

It was during the era of the Long Parliament that the growth of witch-mania proceeded. Three thousand persons are said to have perished, during the continuance of the sittings of that body, by legal executions, apart from many summary deaths inflicted by a ruthless mob. This long and black catalogue of murders was only completed after the number of those put to death had reached 30,000.

Thus, we have with the "Dæmonologie" of the sapient James a record of a popular mania, which in time would have abated, had not the spirit of Puritanism gained strength, and the belief in witchcraft, by the great and educated, had the natural effect of reviving the frenzy among the flexible populace. Once more the old impossible and abominable fancies were revived, but this time witchcraft assumed the form of a religious persecution, and with even a deeper degree of attendant horrors than at any other time.

This mania was not confined to Great Britain, but extended with virulence to North America, where the inhabitants, carrying their religious opinions to excess, yielded a remarkable credence to the popular superstition, and carried it as far, in their modes of judicial punishment, as it had gone in any European nation.

Of the ultimate causes of such transient delusions which run so high and terminate so fatally, no definite explanation can be given. Such moral desolations often pass over the face of society. The thunderstorm does its work—the atmosphere becomes clear, and the sun shines forth and reveals to all the work of death.

Next, we come to the spirit of the religious pilgrimages of which we have spoken. On the establishment of Christianity in the Roman Empire by Constantine in the year 321, Palestine and Jerusalem became objects of interest to all Christians, and crowds of pilgrims flocked to the localities celebrated by the Evangelists; but it was not until Peter the Hermit, with his strange and wild aspect, his glittering eye, his shrill and unearthly eloquence, and the grandeur of his theme, had traversed the whole of Europe, and had produced everywhere the most extraordinary sensations by his pathetic descriptions of the state of Jerusalem and the Christians there, that the love of adventure, the spirit of chivalry, and the desire to wage deadly war with falsehood and guile, burst into a passion so powerful and deadly, that the force of it not only overmastered thousands of noble and refined human beings, but compelled into his heterogeneous train, robbers, murderers, and all sorts of criminals, until the vast masses set in motion towards Holy Land amounted to millions of souls. Evidently, very numerous were the miscreants and fanatics of that age; poor wretches who had been hurried on by a blind, impulsive kind of mania into the enterprise, without forethought or preparation of any sort, and whose main anxiety was to be the first to reach the sacred shrine. There were to be seen hundreds of thousands of human beings, the mere tools of the enthusiasm, and the monster result of that grief and rage which had filled the breast of Peter the Hermit; and the conclusion and consummation of their desire was a carnage and work of blood in the redemption of the very birthplace of the religion of peace.

Religious Impostors.—Of religious excesses originating in imposture, or the delusions of overheated neurotic temperaments, the world has had many lamentable examples; and of all excesses, that of excess in mistaken or misguided devotional feeling has proved the most dangerous. History abounds in accounts of Messiahs, and of their contagious influence and temporary success in working on the credulity of their followers. We have only to mention the Munzer fanatics in Germany, who, amid the turmoil of the Reformation, by their pretended visions, miracles, and prophecies, kindled the flame of fanaticism in the minds of the peasants; and the equally infatuated zeal of the followers of Bockholt or John of Leyden. Here, in both cases, the doctrines of an hallucination spread into a popular belief which held its sway over great multitudes of people. In almost all countries of Europe an enormous number of these people preferred death in its worst forms to a retraction of their beliefs. Neither the view of the flames kindled to consume them, the ignominy of the gibbet, nor the terrors of the sword could shake their invincible constancy, or induce them to abandon tenets that appeared dearer to them than life and all its enjoyments. The would-be more enlightened policy of modern times would either leave alone such beings, or, at the most, endeavour to consign them to the humane treatment of a lunatic asylum.

The mass of absurdities—blasphemous in the extreme, if viewed as the outpourings of mental sanity — of the Newfoundland prophet, Richard Brothers, excites a sense alike of the painful and ludicrous. That the man was neither more nor less than a confirmed lunatic may be easily seen by the perusal of the gross specimens of his ravings as set down in his work, called "A Revealed Knowledge of the Prophecies and Times." The victims of such a contagious epidemic create a world of their own around them, and in imaginary intercourse with the beings that people it, find more pleasure than in any commerce with the material creation. Richard Brothers, as far as he lived at all for the ordinary world, lived only to afford another proof of the irregular exercise of the superstitious feeling and love of the marvellous in man, as well as of the difficulty which even education has in repressing their undue exercise. During the past century the religious world has been scandalised by the wild fancies and pretensions of several female fanatics, equally mad or self-deceiving with the most visionary impostors of the male sex.

Anna Lee, the founder of the religious sect commonly called *Shakers*, was a violent, hysterical, vehement, and ambitious girl, who claimed to be the Bride of the Lamb seen in Revelation by St. John. Yet, such was the powerful influence of the morbid visions of this illiterate, hysterical factory-girl, that the course of American thought and sentiment was considerably altered by it. The extravagant pretensions of the fanatics Jemima Wilkinson ("the universal friend"), Mrs. Buchan ("mother of the elect"), and Joanna Southcott, with her 100,000 excited followers, are other instances of uncouth epidemics, in which thousands of crazy dupes became infected by the crude and oftentimes coarse raving of a maniac. The religious wanderings of Matthews, "the prophet," excited a frenzy in America, which in ordinary times would lead to no other result than the committal of such a madman to an asylum. The assumption of Divine power by John Nicolls Thoms in Cornwall, was followed by confinement in an asylum, but not until his exhortations and denunciations had induced an enthusiastic fervour amongst his vast concourse of deluded followers. Lastly, mention must be made of the 80,000 enthusiastic disciples of Sabbathias Zwi, who claimed to be the Messiah, and endeavoured to convert all humanity by the magic and mystical doctrines of the Cabbala.

Closely allied with hysterical insanity on the one hand and epileptic insanity on the other—and when ceasing to be sporadic, forming the best illustration of epidemic insanity—is a form of mental disorder known under the various designations of Tarantism, Dancing Mania, Tigretier, Chorea-Demonomania, and Choreomania, but which must not be confounded with ordinary chorea in combination with insanity.* It consists of an irresistible impulse to active movements, remarkably stimulated by music, with marked perversion of the feelings. On several occasions this remarkable disorder has deeply affected the course of political and religious national life.†

Speculative Manias.—Another important series of epidemics are catalogued under the speculative manias, among which the avaricious desire of being speedily rich has been a prominent

* Bucknill and Tuke, "Manual of Psychological Med.," p. 400.

† Dr. Tuke has given the narrative of epidemic choreomania occurring in Madagascar, "Manual of Psych. Med.," 3rd edit.; and Dr. Constans has given an interesting account of the "Epidémie d'Hystéro-Démonopathie," in 1861, at Morzines, in the Department of Chablais (in Haute-Savoie), Paris, 1863.

feature. Sometimes the schemes, though visionary, arose with no bad intention, being merely a consequence of inconsiderate enthusiasm; but in others, if not originating from deception, they were continued with a reckless disregard of consequences, and evidently for the sake of immediate and unjustifiable returns.

John Hunter laid down the law, that "every part of the body sympathises with the mind; for whatever affects the mind, affects also the body in proportion." * The mischievous influence of sympathy or imitation is exemplified in the following case quoted from Dr. Tuke's work. In a workshop where sixty women were at work, one of them after a violent altercation with her husband had a nervous attack. Her companions pressed round her to assist, but no sooner had they done so, than first one, then another, fell a prey to the same kind of attack, until twenty were prostrated by it. The contagion appeared likely to spread through the company, but was checked by clearing the room.† That there is a pernicious influence in connection with reading the graphic reports of atrocious crimes is at the present day manifest; the images of these crimes are impressed upon the mind through the senses, and with defective control there is simply a reproduction of the acts as pictured. There can be no doubt, that *suicide* is frequently brought about by suggestion in this way. A case is quoted by Tuke of a sentinel in Napoleon's army, who committed suicide by hanging himself in his sentry-box, and whose example was immediately followed by several others, when they became his successors in the same box, until Napoleon found it necessary to entirely destroy the box by fire. The comparatively recent epidemic of suicide among the youth of Austria furnishes us with another illustration. Every youth who failed, or nearly failed, or fancied he might fail at any examination whatever, immediately began to think of suicide, and sometimes even committed it, without waiting to hear the result of the examination.

Of *mimicry of disease* there are innumerable instances. The cases quoted by Weir Mitchell, of six or seven inmates of the

* Tuke, "Influence of Mind on Body," p. 167.

† "Journ. des Connaissances Med. Chir.," Feb. 1, p. 16, 1851.

Pennsylvania Hospital who imitated another patient suffering from croup; and Durand's account of the influence of imagination causing vomiting in 80 out of 100 patients simultaneously, exemplify the influence of suggestion.

Tamburini and Tonnini* make a distinction between endemic and epidemic insanity. *Endemic* insanity is confined to one region or district, but may extend and become epidemic. Besides their local character, the particular forms of endemic insanity are described as being stable, and as tending to propagate without any active moral contagion. They are also thought to reflect the tendencies of primitive races. When the endemic psychopathies spread among people of different habits and conditions, the disorder tends to become less intense and less frequent. *Epidemic* insanity extends over a much larger area than endemic. The epidemics may develop under the influence of the same psychological tendencies—*i.e.*, the same morbid tendencies may exist throughout a large number of individuals. It is more common, however, for an epidemic to arise through the influence of some individual who infects others with his own morbid ideas.

The psychic manifestations may take the form of (1) illusions or pure hallucinations, which affect many persons at the same moment; (2) morbid psychoses, in which there may be melancholia, excessive religious zeal, political or pseudo-scientific intemperance; (3) sensory perversions with ecstasy, impulses, and morbid activities; (4) actual convulsive attacks, as in the various epidemics of hysteria, epilepsy, and chorea.

Insanity may be communicated (*Folie à deux*) from one individual to another in various ways:—(1) Occasionally one patient becomes infected by the mental disorder of another. Not only may the actual existing delusion or moral perversion be communicated, but also numerous abnormal activities, such as the rhythmical movements of idiots. Thus, in County asylums it is not uncommon to see several insane individuals of a degraded type who have copied the perverted activities of their neighbours. (2) In consequence of the shock of witnessing an attack of insanity, and the strain occasioned by nursing, etc.,

* "Tuke's Dictionary of Psychological Medicine," p. 434.

some individuals break down mentally and may acquire the same insane ideas as their patients. These instances of course differ from those in which two or more persons become insane simultaneously from the same cause.

On the whole, however, from an analysis of the clinical facts, it would appear justifiable to state, that (1) the insane have little influence upon the sane—*i.e.*, other things being equal, attendants upon the insane are not especially liable to attacks of insanity. (2) When an individual breaks down in consequence of association with the insane, the probability is, that that individual has a neurotic inheritance, or is subjected by disease or other causes to mental and physical strain. (3) It is more common for women to break down than men. (4) The young are more likely to become affected by the delusions of the old than *vice versâ;* especially if the old are related to, and intimately associated with, the development of the former. (5) An individual who is obviously insane seldom influences the thoughts of those who are sane. The greater danger arises from the insane person who is able to conceal his madness and apply his intellect in a methodical way, so as to influence another in the direction of his own delusion.*

Delusions of persecution, and the beliefs in conspiracies to defraud of property, are the commonest forms of communicated insanity. Patients seldom mimic an attack of mania, melancholia, or dementia. Occasionally among the hysterical there is mimicry of the paralytic affections of their neighbours. One patient at present in Bethlem has copied the incoherence of a maniacal patient, but his efforts have the appearance of being voluntary, and the seriality of thought is too evident to resemble the rapidity of utterance, and the inconsequent ramblings, of the acute maniac.

Of direct stress and the various physical causes of insanity we shall speak in the next chapter. It only remains for us now to sum up our conclusions with regard to the influence of our social environment.

Sooner or later the question must arise within the mind of each of us whether, as physicians, it is our duty to study man as man, devoting ourselves to the contemplation of the mental

* "Tuke's Dictionary of Psychological Medicine," p. 241.

faculties possessed by him in a greater degree than any other animal, and to apply these laws as principles for the synthetical explanation of the phenomena of the understanding, and thereby support the philosophy which Hippocrates contemplated, and which led him to give the character of "Divine" to the medical art; or whether we are to brand ourselves with the reproach of advocating an irrational materialism. When we reflect that, in the old-world days, the relations of mind and body were recognised and discussed in their various bearings, and that the fundamental problems of Hippocrates are still unsolved, we marvel that, even at this day of methodically regulated experimental investigation, we are no nearer the solution of the all-important problem of the ultimate relation of the mind and body.

In the history of philosophy, we see in clear detail that all our modes of thought, so far as they rest on specific fundamental differences, have been anticipated in the systems of the Greek philosophers. No matter how the various problems may clothe themselves to us, the human mind has always been confronted with the same metaphysical *impasse*. When we review the philosophy of to-day, we see its exact representation in antiquity. Plato's "Freedom of Rational Ideality," Aristotle's "Legality of Intelligible Realism," Zeno's "Intellectual View of the World," and the materialistic views of the Epicureans, fully represent the possible directions of our own present thoughts.

The philosophy of the infinite, far from becoming a source of aberration of thought, is the ultimate point of our mental evolution. Beliefs which are narrow and deal with traditions in the concrete are but symbols of dissolution. A true and philosophical religion raises the mind above a mere incidental emotionalism, and gives stability. With no religion, and no moral obligation, the organism becomes a prey to all the lusts of the flesh with their consequences. Gasquet* observes, that religion may either produce or tend to hinder unsoundness of mind; that it may cause certain symptoms of insanity, or modify them; and lastly, that it may be employed as a means of moral prevention and treatment. He believes, that every

* "Tuke's Dictionary," p. 1088.

religion, however widely it may differ from our standard of the truth, if it enforces the precepts of morality, is a source of strength to the sound mind that sincerely accepts it.

"An agent which can effect so much good must, however, be equally potent for harm. The mind on which religion acts may be abnormal; in which case it is not wonderful, as an old author puts it, 'that the light should be painful to the sick eyes, which to healthy ones is delightful.' Or the fault may lie in the application of religion, like a drug which can save a life, but is equally able to destroy it, if given inopportunely or excessively. The sense of responsibility to omniscient justice may pass into a belief in condemnation irrevocable and inevitable; the habit of communing with God may easily grow into self-contemplation and ecstasy; the repression of the lower part of human nature may be strained into practices ruinous to health of mind and body. The common factor in all these exaggerations is *fanaticism*, which looks only at one side of religion, and commits the fallacy of supposing that the dependence of man upon a higher being must supersede all those other duties which, on the contrary, derive therefrom their greatest sanction. As one of the natural growths of an ill-balanced mind, fanaticism is closely akin to the other manifestations of the insane temperament; and this accounts for the fanatical habit of mind that is so often associated with the hereditary neuroses, above all with epilepsy. Overstrained and one-sided religious views are, however, not so often the primary cause of an attack of insanity, as its first symptoms, though symptoms which in turn act as causes of further evil and intensify the disease. For instance, an endeavour to study the mystery of existence and solve the problem of evil has been rightly denounced as highly dangerous to mental health; yet it is recognised as an early symptom ('Grübelsucht') of an otherwise deranged mind. Or, again, a case of melancholia in which religious delusions seem at first sight to have been the cause of all the troubles, will be found, if traced from the beginning, to have originated in disordered bodily health."

The same author believes, that a delusion which is to account for the morbid feelings of a lunatic must be constructed out of the previous beliefs, and that many religious delusions must, therefore, be confined to the members of particular religious bodies. The form of mental disorder generally determines the colouring of the religious delusion: thus maniacal patients have exalted delusions; melancholiacs depressed ones; general paralytics those of an inconsistent and wild character; while chronic delusional cases have more or less definitely fixed ideas that they are special messengers of God, or even the Almighty Himself. Gasquet mentions the mixture of erotic and religious excitement in many epileptics, the simple belief in perdition common in amenorrhœal melancholia, and the manner in which insane masturbators will assert that they are heroes and martyrs under some special dispensation of Providence.

Dr. Hack Tuke classifies religious delusions according as they (1) accompany the mental development of over-stimulated and injudiciously educated children (fear, remorse, etc.); (2) characterise the insanity of pubescence (fear, depression, and wish to do penance); (3) are caused by self-abuse (self conscious, unpardonable sinners, weak minded, auditory hallucinations, visions, trances, ecstasies, suicide); (4) are associated with (so-called) paronoia (delusions of superior spirituality, fanaticism); (5) are associated with epilepsy, dementia, and general paralysis (rarely fear, usually unworthiness, or exalted ideas); (6) are observed in melancholia and climacteric insanity (unworthiness, fear of endless life, etc.); (7) arise in chronic mania or toxic insanity (usually exalted).

Physical Environment.—*The Seasons: Climate.*—Parchappe and Esquirol have estimated that admissions into asylums are more numerous during the summer months. Guislain believes, that there is some relation between the warmth of the atmosphere and mental disturbance. Aubanel and Thore also formed the same conclusions. Guislain has pointed out, however, that we do not find more insanity in hot climates than in cold.*

Moon.—The influence of the moon is doubtful. Most modern observers believe, that mere increase of light is sufficient to cause the excitement in some patients.

Occupation: Town and Country Life.—Sibbald believes, that of insane patients a more considerable proportion may be assigned to previous urban surroundings than has generally been supposed, that cases of general paralysis and other rapidly fatal diseases of the nervous system are more common under the conditions of town life, and that attacks of insanity, swift in their onset and swift in their retreat, are also more common. The general opinion now is, that civilisation, abounding with artificial conditions and influences, is the most general cause of stress and strain, and, as a consequence, mental disorder, irre-

* Bucknill and Tuke, "Psychological Medicine," p. 78.

spective of any special occupation or locality. When we discussed the special senses, we took account of the forms of illusion as determined by the environment and by the organism, and we saw how unusual relations between the physical environment and the organism afforded data for misinterpretation by the mind.

In conclusion, the student will do well to bear in mind, that next in order to the process of determining the nature and significance of phenomena is that of discovering their causes. We cannot afford to dispense with philosophy, for it is by that, in our efforts, the laity are most apt to measure us. Instead of bewailing our ignorance of natural causes as the most fruitful source of superstition and disease, it is our duty to exert the prerogatives of philosophy, and to endeavour to free ourselves from the traditions and shadowy apprehensions of others. It is eminently true of the medico-psychologist, that the fears and hesitancy with which he approaches the treatment of mental disease are in exact proportion to his ignorance of its causes. If he is only a physiologist, or only a psychologist, he does not possess that privileged understanding of cause which alone can give him confidence. He must be both. He must combine a philosophy with a handicraft. In his efforts to combine the two, however, he must beware how he proceeds. Nearly fifty years ago Simon said, "It would be difficult, in polite language, to find phrases sufficiently strong for stigmatising, according to its deserts, the state of medical ætiology. . . . . In the absence of exact physiology how, indeed, could it exist, save as nurses' gossip and sick men's fancies, and the crude compilations of a blundering empiricism?"

Since this statement was made great advance has taken place in many departments of our science. We still, however, are asked to accept many vague generalities of expression. At every turn we are asked to rest satisfied with *post hoc, ergo propter hoc*, as our inductive formula. Some of our most advanced schools of thought try to teach us to say, "I don't know I am sure" instead of "I am sure I don't know." Lord Bacon reprobates the "over-early and peremptory reduction of knowledge" into systems as a "mere covering and palliating of ignorance, that men have used of a few observations on any subject to make a solemn and formal art, by filling it up with discourse and accommodating it with some circumstances and directions to practise"; and he further notes, that "as young men when they knit and shape perfectly, do seldom grow to a further stature, so knowledge, while it is in aphorisms and in observations, it is in growth; but when it once is comprehended in exact methods, it may perchance be further polished and illustrated and accommodated for use and practice; but it increaseth no more in bulk and substance." *

When we review the absurd superstitions that have been connected with the so-called congenital malformations, and observe the process by which we have been led to the solution of the mystery in simple and intelligible laws, the furnishing of such a physiological standard for interpreting the apparent anomalies of birth, encourages us to persevere in trying to find the true teleological interpretation of whatever in nature may seem at first to be causeless and capricious. In the problems of pathology there are always two methods of investigation.† Firstly, morbid phenomena must be generalised in the direction of the vital forces concerned in their production; secondly, morbid influences or causes must be contemplated, not in the multiformity of the outward world whence they originate, but in their relation to the living agent, whose excitability is the condition of their causativeness; the living agent whose powers and functions they excite or depress, or whose organic material they modify.

* "Advancement of Learning," 31, and "Interpretation of Nature," 18.

† Simon, "Aims and Philosophic Method of Pathological Research," London, 1847.

CHAPTER XV.

The Factors of the Insanities (*Continued*).

Physiological Periods of Life—Infancy—Causes of Idiocy and Imbecility —Types of Infantile Mental Defect—Night-Terrors—Dreams—Nightmares—Somnambulism—Infantile Insanity—Causes—Heat —Fevers—Masturbation—Puberty—Adolescence—Puerperium—Menopause—Senescence—Bodily Affections as Factors—Genital —Urinary—Digestive—Circulatory—Respiratory—Other Diseases —Neuroses — Spinal — Sympathetic — Cerebral — Intoxicants — Immediate Factors — Vaso-Motor — Vascular — Nutritional — Hughlings-Jackson's Scheme of Factors — Conclusions.

THE FACTORS OF THE INSANITIES.

In order to make our account of the ætiology of insanity fairly complete it is essential that we should devote our attention to the consideration of those affections of the body which either determine or are associated with morbid mental states. We cannot undertake to discuss in detail all these numerous relationships. It must suffice that we discuss the various questions from a general point of view, and note more particularly those bodily and mental perversions which are most commonly met with as associated conditions.

The **physiological periods of life** which are most fraught with danger to an individual are those of birth, infancy, puberty, pregnancy, the menopause, and senility. We now propose to study these periods somewhat in detail.

Infancy.—The various forms of idiocy and imbecility may arise from causes acting before birth, at birth, or subsequently. Of the causes acting before birth we have to note—in addition to those dependent on a neurotic inheritance of insanity, epilepsy, syphilis, alcoholism, tuberculosis, etc.,—the liability of the mother to suffer from abnormal mental or physical conditions during gestation. The causes acting at birth may be, premature birth, difficult labour, instrumental delivery, accident, asphyxia neonatorum, or primogeniture. Those acting subsequently to birth may be, infantile convulsions, epilepsy, cerebral affections, febrile disturbances, paralytic affections, sunstroke, nervous shock, or physical injury to the head.*

Among the more important factors which determine mental defects or aberrations in the infant, we have to note the following structural abnormalities of the brain and spinal cord:—(1) *Anencephalus*,† in which the vault of the cranium is absent, the base of the cranium being occupied by a mass of connective tissue and blood-vessels, formed from ingrowths of the pia mater; (2) *Absence of the prosencephalon*,‡ in which there is found a rudimentary thalamcephalon, the cerebellum, pons, and medulla being reduced in size owing to the absence of development of the prosencephalic fibres; (3) *Cyclops*, § in which there is an undivided anterior cerebral vesicle occupied by only one ventricle, and in some cases the presence of only a single optic nerve and a single eye. One case has been described, in which there was merely a superficial furrow between the frontal lobes. A tri-lobular brain, and a double brain of four hemispheres, have been recorded.

The other abnormalities of the brain and spinal cord have been grouped as follows ‖ :—

* Shuttleworth and Fletcher Beach, "Tuke's Dictionary," p. 659.

† "Encyclopædia of Diseases of Children," vol. iv. part II. p. 728.

‡ Starr, "Journ. Nerv. and Ment. Diseases," July, 1886; Dana, *ibid.*, January, 1888.

§ *Vide* "Edin. Med. Journ.," vol. xxxii. No. 3; Hadlich, "Arch. f. Psych.," 1880, Bd. x. p. 97; Wille, *ibid.*, 1880, Bd. x. p. 97; Heydenreich, "Virchow's Archiv.," iv. 1885, Bd. c. p. 24; "Internat. Monatschr. f. Anat. u. Phys.," 1888, p. 11; also "Virchow's Archiv.," Bd. cvi. p. 390.

‖ McNutt and Post, "Encyclopædia of Diseases of Children," vol. iv. p. 730.

1. *Abnormalities accompanied by defects in the envelopes of the part* :—

(*a*) *Cranioschisis* . . { *Encephalocele.* *Hydrencephalocele.* *Meningocele.*

(*b*) *Rachischisis* . . { *Myelocele.* *Meningocele spinalis.* *Spina bifida occulta.*

2. *Abnormalities in which the envelopes are entire* :—

{ *Hydrocephalus.*
Microcephalus.
Porencephalus.
Aberrant arrangement of fissures and convolutions.
Agenesis of cortical elements, commissures, and associative tracts.

The consideration of these structural abnormalities is of great interest, and at the hands of Spitzka,* Mills,† and Sachs,‡ the arrangement of convolutions and the degree of development of the nerve-elements, in connection with the brains of imbeciles and criminals, have received a certain amount of attention. We lack space, however, to give a more complete review of the subject.

Of the various types of congenital and acquired imbecility which may be diagnosed during infancy, we have to note the following § :—

1. **Congenital,** in which the individual is usually of a low type, with a tendency to physical weakness, strabismus or nystagmus, a highly-arched or elongated palate; also, automatic movements, contractures, or spastic rigidity. Such patients not infrequently slaver, and appear to be incapable of caring for themselves. Their special senses may be defective or only partially developed, and there may be little or no power of attention or volition.

* "American Journ. of Neur. and Psych.," 1882, p. 386.
† "Journ. Nerv. and Ment. Dis.," Sept. and Oct. 1886.
‡ *Ibid.*, Sept. and Oct. 1887.
§ *Vide* Shuttleworth, "Brit. Med. Journ.," Jan. 30, 1886.

The types of *congenital imbecility* have been classified as follows :—(*a*) *Simple congenital*, which include those forms without any obvious physical deformity of the head or limbs. The Mongol or Kalmuc idiot belongs to this class. A typical Mongol idiot, however, is usually of stunted growth and brachycephalic. His fingers and hands are short and dwarfed. Defective circulation, and inability to resist acute diseases, usually incapacitate them from attaining to adult age. (*b*) *Microcephalic*, in which the brain has ceased to grow, due either to some internal cause or to the premature closure of the sutures of the skull. As a general rule, heads below 17 inches in circumference are held to be too small for ordinary intelligence. Vogt believes, that microcephaly is an instance of atavism due to the inheritance from some very remote ancestral ape. (*c*) *Hydrocephalic*, in which the fontanelle is raised: the head is globular, with the widest circumference at the temples, and occasionally a slight bulging above the superciliary ridges. (*d*) *Scaphocephalic*, in which the head is keel-shaped. (*e*) *Paralytic*, in which there is arrest of development of part of the brain, due to injury, disease, or apoplexy. In such cases the mental powers can sometimes be cultivated to a certain extent, but the physical development is locally arrested. Usually one hemisphere only is affected. (*f*) *Cretinism*, which may be sporadic or endemic.

2. The types of **acquired** imbecility are as follows:—(*a*) *Eclampsic*, in which there is arrest of development of the mental functions, due to the occurrence of convulsions soon after birth, and which have damaged the structure of the brain. (*b*) *Epileptic*, in which, as the result of frequent fits, the intellect becomes dull, and the individual becomes incapable of advancing intellectually. (*c*) *Paralytic*, in which the paralysis is acquired at some period after birth. Some of the cases are due to the occurrence of fits, or to cerebral apoplexy. (*d*) *Inflammatory* is usually a sequel to some acute illness, such as measles, typhoid fever, whooping-cough, sunstroke, etc. The amount of impairment of the mental faculties depends in great part upon the amount of damage to the brain-tissues. (*e*) *Hypertrophic*, which may or may not be associated with rickets. Usually, the brain is not so large as in hydrocephalus. The head is somewhat

square, and bulges above the superciliary ridges. Hypertrophy is said to differ from hydrocephalus in the fact, that in the former there is no elasticity over the late-closed fontanelle as in the latter. In hydrocephalus the distance between the eyes is increased; in hypertrophy this is not the case.* (*f*) *Traumatic*, due to a fall or blow on the head. Sometimes the injury has caused the occurrence of fits, which serve to prevent mental improvement. (*g*) *Endemic cretinism*, in which there are none of the fatty tumours in the posterior triangles of the neck like those found in the sporadic cretins. Usually, cretins are classified according to their degree of development. The lowest types are termed "cretins"; those with a certain amount of intelligence "semi-cretins"; while those who have a fair amount of mental power are termed "*crêtineux*."

Insanity is comparatively rare in early infancy. It occurs in children who have a strong neurotic inheritance, and manifests itself by terrors, nightmares, nocturnal delirium, and visual hallucinations.† Some children have morbid and often dangerous impulses. Attacks of melancholia or mania are rare, although some writers mention cases they have had to deal with. The dreams, somnambulistic attacks, and night-terrors of childhood are explained as the result of loss of the higher, and exaltation of some of the lower, cerebral functions. When the higher functions (those concerned with consciousness) are suspended, their inhibitory influence is lost; and the lower functions, no longer under control, run wild in various ways. According to Hughlings-Jackson, when these higher functions are suspended, two sets of symptoms are observed—first, the deficiencies directly owing to the suspension of the higher functions; second, those which arise from the unnatural prominence of the lower functions, which manifest themselves in response to various excitations.

Night-terrors may occur every night, every few nights, or at irregular intervals. Sometimes a child has several attacks during the same night. Usually they occur an hour or two after going to sleep. Between the periods of the first and

* Fletcher Beach, "Hypertrophy of the Brain in Imbeciles"—"Journ. Ment. Science," April, 1881.

† Regis, "Mental Medicine," p. 331.

second dentition, children are particularly liable to night-terrors, which may continue even to the age of puberty. Each attack is characterised by excessive fear, screaming, and usually some terrifying hallucination. Night-terrors are more commonly observed in children of a neurotic, scrofulous, or anæmic type. The immediate exciting causes may be indigestion, worms, teething, enlarged tonsils, ear disease, catarrh of the respiratory passages, irritation of the skin, ill-ventilated bedrooms, fevers, or to various conditions of mental excitement during the day. Steiner* mentions scrofulous ophthalmia and other ailments as being sufficient to cause night-terrors. Putnam† believes there is no question that, in some cases, every attempt to find an immediate excitant of the attack has been fruitless, and he advances the hypothesis that, as with epilepsy, there may be cyclic explosions in the form of night-terrors for which the brain is preparing all the time between the attacks, so that the attacks take place not as the result of any disturbance of other organs, nor even under the stimulus of distorted recollections, but purely or mainly as the result of a certain degree of tension acquired by the brain in this interval.‡

Soltmann§ believes, that if the attacks occur spontaneously, without any outside influence, and if visual hallucinations are always present, there must be some abnormal activity of the central sensation areas (pulvinar of the optic thalamus, corpora geniculata, quadrigemina, and cortex of the occipital lobe)—*i.e.*, it is a hyperæsthesia of the optic tract, or a cerebral neurosis. Silbermann‖ and Baginsky¶ believe, that the attack may be either *idiopathic*, in the form of a transitory hallucination of sight, due to increased irritation of the brain-cortex, or *symptomatic*, as a reflex neurosis of the pulmonary vagus resulting in dyspnœa, and thereby in a sensation of subjective terror.

It is not common for night-terrors to be associated with organic brain disease or with epilepsy. Occasionally, however, children

* "Jahrbuch für Kinderheilkunde," 1875.

† "Keating's Encyclopædia of Diseases of Children," vol. iv. p. 1013.

‡ Alcohol, belladonna, stramonium, quinine, and several other drugs are said to produce night-terrors in children.

§ "Handbuch der Kinderkrankheiten," 1880.

‖ "Jahrbuch für Kinderheilkunde," 1883.

¶ "Lehrbuch der Kinderkrankheiten," 1887.

affected with night-terrors become epileptic. Moizard* quotes the case of a child who suffered from night-terrors, then hallucinations, somnambulism, and finally epilepsy. Henoch† mentions a case in which night-terrors took the place of epilepsy. The apparent relationship between the two conditions prompted Money‡ to regard night-terrors as a species of reflex cortical epilepsy.

Dreams, nightmare, and somnambulism occur in children, due to causes similar to those of night-terrors. In nightmare there is generally some distressing hallucination with the feeling of inability to move. In somnambulism the child actually walks about during his sleep. Sometimes adults perform various complex intellectual acts during a somnambulistic attack; children seldom or never. The memory of what has happened during the somnambulistic attack may be imperfect or entirely absent. Insomnia in infants and children may be due to digestive disturbances, cold, heat, or to want of ventilation. Over-fatigue or nervous excitement during the daytime also tend to produce it, and, as a consequence, there is imperfect brain-rest with its disastrous sequelæ.

Hagen§ estimated that one in 70,684 children annually become insane, excluding those born so. The immunity is doubtless due to the fact that infants are little subjected to the vicissitudes, intoxicants, and wear and tear of a more advanced age.

Among the more important factors which determine an attack of insanity in a child, we may mention sudden changes in temperature, or over-exposure to the sun.‖ Affections due either directly to heat of the sun (*coup de soleil*), or indirectly to heat and other influences (*coup de chaleur*), are attended with prostration of the nervous powers, syncope, debility, vertigo, nausea, and incontinence of urine; or there is venalisation of

* "Revue Mensuelle des Maladies de l'Enfance," 1884.

† "Vorlesungen über Kinderkrankheiten," 1889.

‡ "Treatment of Diseases of Children," 1887.

§ Moeller (Heppenheim), "Beitrag zur Lehre von dem im Kindesalter entstehenden Irrsein, Statistische Untersuchungen über Geisteskrankheiten, Erlangen," 1876.

‖ Steiner, "Compendium der Kinderkrankheiten"; also Hyslop, "Journ. Ment. Science," Oct. 1890.

the blood, with absence of perspiration, suppression of urine, and constipation. The most abiding results of heat-stroke are all referable to impaired functional energy of the cerebro-spinal system, and this impairment shows itself either in motor paralysis, hyper- and dys-æsthesia of the nerves of common and special sensation, in debility, and lastly, in undue excitability of the cerebral regions concerned with the emotions.

In children, as in adults, the neuroses following sunstroke are somewhat similar to, and have much in common with, the traumatic neuroses. The chief clinical features noted in children whose mental perversions have been attributed to sunstroke are:—(1) The absence of bodily infirmity; (2) the full development and comparatively normal dimensions of the muscular and osseous systems (including the shape of the head, jaws, and teeth, etc.); (3) the special affections of speech, either of a temporary character immediately following the attack, or as a continued impairment or failure in development of the faculty; (4) the frequency of the occurrence of fits immediately after the attacks, lasting for a short period, but not continued through life; (5) the defective or perverted moral state, as seen in various grades, from mere disobedience, to propensities peculiar, dangerous, or even homicidal; and sometimes, though rarely, habits of a degraded nature; (6) the small mental capacity, with failure to improve much by the ordinary educational methods; (7) the attachments, antipathies, and peculiarities, which were in the most cases retained through life: also an absolute inability to compete with their fellow-beings, or to aid their own survival.

Of other accidental causes which operate directly or indirectly on the nerve-centres, we may mention head-injuries, injuries to the peripheral nerves, diseases of the throat, nose, or ears, digestive disturbances, and the presence of intestinal worms. The last named factor is believed to produce eclampsia, epilepsy, chorea, hemiplegia, and paraplegia in children. The occurrence of an attack of mania in connection with the presence of intestinal worms is thought by Spitzka to demonstrate, that the mania is a psychical equivalent of a reflex epilepsy.

Febrile and other acute disorders also determine the onset of an attack of insanity. Of febrile diseases, scarlet, typhoid, and rheumatic fevers, and measles, are apt to be attended by the graver mental disturbances. Spitzka believes, that the psychical results are due to the specific disease-germ and its direct noxious influence on the nerve-centres, and only indirectly by the profound nutritive disturbance. This opinion is based upon the following series of facts:—(1) Analogous affections, such as the progressive sopor following diphtheria, are accompanied by evidences of microparasitic invasion of the nerve-centres; (2) the psychical results of post-febrile insanity are different from those resulting from simple nutritive disturbance; (3) the organic nervous diseases exceptionally following essential and exanthematous fever are usually multilocular, and indicate the operation of an irritant distinct from a mere deprivation of nutriment.

Masturbation is regarded by some writers as an important ætiological factor; by others, however, it is regarded mainly as a symptom. Infantile masturbators are liable to become melancholic, stuporose, and demented; or they may be impulsive, with maniacal outbursts, and even delirious. According to Spitzka, imperative conceptions, morbid fears, and *folie du doute* are frequent symptoms.

Puberty, from the age of 14 or 15, proves itself to be a dangerous period of life to certain individuals, and more especially to those who have inherited a tendency to neurosis. The mental characteristics at this period are undergoing a process of evolution, which is particularly fraught with the danger of becoming excessive in special directions and with a proportionate degree of dissolution in other directions. The intellectual advance of the male is apt to tend to specialisation, whilst the emotional life of the female is apt to develop at the expense of the intellect and the power of control. Both at puberty and adolescence the mental characteristics are apt to become morbidly intensified. According to Clouston, of those who become insane during puberty or adolescence 78 per cent. are maniacal, while in the remaining 22 per cent. the prevailing symptoms are melancholic, delusional (paronoic), or stuporose. One prevailing feature of all the cases is the tendency to remission and periodic recurrence. It is comparatively seldom that the maniacal attacks approach delirium. In melancholiacs it is common to find stupor also. Hysterical attacks sometimes occur in females, rarely in males. Sexual vice or self-abuse may be a symptom or a cause.

Menstrual irregularity is frequently assigned as a cause of the mental attack, but possibly the irregularity is sometimes merely a symptom or an associated affection. It is readily imaginable that menstrual derangements may interfere with the activities of the brain, and, conversely, that cerebral derangements may affect the menstrual flux. Bevan Lewis has noted the almost constant impoverishment of the blood in adolescent and pubescent insanity.

The *puerperal* period is attended by such novel relationships, both physiological and mental, that the tendency to morbid reaction becomes very powerful, especially in those with an hereditary predisposition. Under the term "puerperal" insanity, we are accustomed to class the mental affections occurring during the periods of gestation, parturition, the puerperal state, and lactation. In addition to the factors of heredity, we have to note the various physical causes, such as debility consequent upon labour, suppression of the lochia or the milk, and the exhaustion from prolonged lactation. Former attacks of insanity predispose to puerperal insanity. Certain it is, that an attack of puerperal insanity is likely to be repeated with subsequent births. The fact, that some women break down mentally with every child-birth may, in great part, be attributed to development of the element of expectancy. We have already mentioned many of the more or less striking mental peculiarities during the puerperium, so that it is unnecessary to revert to them.

Some attacks of puerperal insanity appear to be traceable to blood-poisoning, which may arise from external factors, such as alcohol, or from internal factors associated with the suppression of lochia or of milk. During the period of lactation, there is generally marked physical exhaustion, commonly due to prolonged suckling. It must not be forgotten, however, that the uterus may be subinvoluted, or there may be meteorrhagia or leucorrhœa, which may act as exciting factors.

The *menopause* proves itself to be a critical epoch in the mental life of many women, and at this period intellectual and moral perturbations are liable to develop. The factors which give rise to the morbid manifestations may be associated with the physiological suppression of the menses, or with other causes. In brief, we may say, that the predisposing factors are heredity, or previous attacks of insanity; the exciting factors may arise in connection with the physiological changes occurring at this period, or as the result of accidental, physical, or mental causes. With regard to the physiological suppression of the menses, there may arise some doubt as to whether the physiological change determines the mental attack, or whether the mental attack exaggerates the physiological change. In some cases, also, it must be remembered, that the physiological change and the mental affection may be merely coincidental, and not necessarily causal.

In *old age* the process of involution may originate with slowly developing constitutional changes, or with atheromatous degeneration of the vascular system, and an increasing atrophy of all the organs. The abnormal mental manifestations may appear to be entirely functional, or they may be intermediate between functional and organic psychoses. In regard to the functional psychoses, there is little to differentiate them from the psychoses of earlier life. The senile person is as liable to be affected with hypochondriasis, melancholia, mania, or delusional insanity, as the youth. The psychoses associated with organic senile degeneration of the brain are usually characterised by their progressive nature. The manifestations may be due to arterial degeneration, or to disintegration and atrophy of the nerve-structures. Clinically, we have to note, that an attack of melancholia, mania, convulsions, epilepsy, or dementia, may be connected with interstitial or gross cerebral change, such as occur in chronic cerebral atrophy associated with sclerosis, hæmorrhage, or softening from thrombi.

Bodily Diseases may give rise to, or they may be symptomatic of, or merely associated with, morbid mental manifestations. The brief consideration of these bodily affections will now engage our attention.

Affections of the *uterus and its appendages* may be directly associated with mental disorder. Regis believes, that on account of the direct connections that unite the sexual to the cerebral life, there is not a single affection of the genito-urinary apparatus that may not in time affect the brain and cause mental disorder. Certain it is, that affections of the sexual organs in the female are very commonly associated with mental disturbances. Women suffering from uterine disease are apt to become depressed, hysterical, maniacal, and sometimes even dangerously impulsive or suicidal. In males, on the other hand, sexual disturbances are not so commonly the primary factors in determining the mental disease. In this relationship it must be remembered that onanism, seminal emissions, and disease of the urethra, may result from, or be symptomatic of, mental affections. Thus, for example, the senile dement may exhibit a tendency to onanism or other sexual perversion as a symptom of brain decay. Some females complain bitterly about imaginary outrages supposed to have been committed during the night. These delusions may or may not be associated with some existing morbid condition of the genital organs. Wigglesworth found, that of 109 women examined *post mortem* 42 had healthy sexual organs; whereas 67 had more or less serious alterations: in 22 of these cases the disease appeared to be merely associated with the insanity; the remainder suffered from absence of uterus, conical cervix with pinhole os, retroversion, retroflexion, prolapsus, increased volume of uterus, fibroma, chronic peritonitis, uterine cancer, or diseases of the ovaries and tubes. The supposed relative preponderance of uterine lesions in the insane has given rise to the opinion that all females ought to be examined in this respect when insane. This, however, is absurd and unwarrantable. We ought, nevertheless, to be always keenly alive to the fact, that there does exist a strong sympathetic relation, and that not infrequently delusions of sexual persecution are associated with uterine lesions.

Diseases of the *urinary system* do not give rise to any characteristic mental symptoms. The brain may be affected by uræmic intoxication, or vascular lesions may occur in association with kidney disease, but there is no characteristic connection between the evolution of the psychic symptoms and the renal disease. The physical characters of the urine may exhibit departures from the normal in cases of insanity; but these departures add little to our knowledge of the factors of causation.* The attempt to estimate the amount of phosphorus excreted in the urine has proved to be a very seductive line of research; but the relation of the amounts excreted and the chemical changes occurring in the brain are far from being satisfactorily established.†

Disorders of the Digestive Apparatus.—We have already referred to the important *rôle* played by the visceral organs in the promotion of the emotions. A healthy process of assimilation is essential to the feeling of well-being in every individual. Perversion of the process is apt to affect the organism as a whole, and the mind readily takes its colouring from the nature of the visceral stimuli. The insane are particularly liable to digestive disturbances; and often their delusions are not only intimately associated with such disturbances, but one is glad to find them susceptible of amelioration under careful dietetic treatment. Bad teeth, defective mastication, indigestion, and constipation, are not uncommonly found in connection with delusions as to poison or harmful substances in the food.

Of the more important factors in connection with disordered visceral states, we have to note:—(1) Defective development or malformation of the teeth and jaws, as seen in idiots and imbeciles. The teeth of congenital idiots are usually crowded together and sometimes overlapping one another, or they are deficient in enamel and prone to decay. The jaws are frequently narrow and the palate arched. (2) Excessive salivation, as seen in children who have adenoid growths in the nasopharynx. It also occurs in certain forms of idiocy and in mental stupor. Sometimes it is associated with cerebral or peripheral nervous affections, neurasthenia, hysteria, and epilepsy. Diminution in the quantity of saliva occurs in some forms of melancholia and in acute delirium. (3) Some cases have been recorded in which the apparently insane belief, that there was inability to swallow,

* Blyth and Hyslop, "Urine of the Insane"—"Tuke's Dictionary," p. 1340.

† Edes ("Archives of Medicine," vol. x. No. 1, 1883) compares this procedure to that of measuring the rise of water at the mouth of the Mississippi to tell where there has been a thunderstorm in Minnesota (James, "Principles of Psychology," vol. i. p. 102).

was found to be associated with dilatation or an actual diverticulum of the œsophagus. The *globus hystericus* is not infrequently misinterpreted by an insane person, and the abnormal sensations attributed to other causes. One patient in Bethlem used to think that she was being strangled, the delusion in this case probably arising in connection with the effects of a former injury to the throat due to a large dose of hartshorn. (4) Dyspepsia, gastritis, ulceration, the presence of a foreign body in, or cancer of, the stomach, may actually determine the local pain, which is misinterpreted, and the sensations attributed to the presence of a devil, animal, or other object. In taking all these possible factors into account, it must be remembered, that although the local disease may engage the attention of the patient, it does not necessarily determine the misinterpretation of the object of attention. The false concept is often due to cerebral and mental factors, of which as yet we know little or nothing.

Duodenal catarrh, functional perversions of the liver, spleen, or pancreas, peritonitis, helminthiasis, and constipation, have been noted as associated with mental disturbances. We are not in a position to state that disease of one region or of one organ always produces a characteristic mental reaction. The most we can say is, that in a person already insane, a bodily disease may determine the direction of the attention and be the object of misinterpretation. Undoubtedly, derangement of any abdominal organ may influence some individuals both morally and intellectually; but the mental perversion is probably due to a neurotic and unstable brain, which is predisposed to be affected sympathetically. That is to say, the mental perversion is dependent directly upon the brain, which itself is sympathetically affected by the bodily disorder and not upon the local bodily disorder which, as we know from ordinary medical experience, may have little or no effect upon the operations of mind. Several male patients have been admitted to Bethlem with the delusion that they were pregnant. The delusion disappeared with a free action of the bowels; but the mind did not necessarily regain its balance. Such instances serve to illustrate, that bodily diseases may determine the *direction* of the thoughts, and in a manner, therefore, the type of the delusion; but the true cause of the misinterpretation may be due to factors cerebral and mental, which require a much more subtle explanation. Therefore it must not be thought, that bodily diseases necessarily always determine the direction of the thoughts. In fact, some organic visceral diseases are associated with insane ideas which bear no physical relation to the idea of discomfort or pain. In some instances constipation may be the *result* of delusions. Thus, some patients voluntarily refuse to evacuate the contents of their bowels owing to the belief, that they are commanded by God not to do so; others refuse because they wish to retain their excretions and in some way or other bring about a fatal result. Many authors believe that constipation is an invariable accompaniment of melancholia. Undoubtedly, in that disease there is diminution of the secretions and deficiency in peristaltic action of the alimentary canal.

Diseases of the heart and circulatory apparatus have long been noted as factors in the production of morbid mental states. The mind is so readily influenced by the conditions of the cerebral circulation that we cannot but recognise how intimate must be the relation between the two sets of processes. We are not aware that insanity is more often attended by heart disease than is sanity; nor can we say, that any particular form of vascular affection occurs more frequently among the insane than among the sane. The mitral valve is more commonly affected than the aortic, and cardiac hypertrophy is frequent. Atheromatous conditions are frequently found in senescence. In order that the brain may discharge its functions satisfactorily it is essential, that the arteries, veins, and capillaries be healthy, that there be no obstruction to the circulation in the cranial cavity, that the movements of the cerebro-spinal fluid be unimpeded, and that the blood itself be adequate in amount and efficient in quality. In heart disease any of the above conditions may be deficient, and, as a consequence, there may be impaired nutrition, access of poison to the cerebral cells, or even total destruction of the brain-tissue.

Mickle* believes, that special forms of cardiac valvular lesions are attended by fairly-well defined mental symptoms. Mitral regurgitation is attended by some depression with

* "Goulstonian Lectures," 1888.

delusions of suspicion and persecution ; not uncommonly the patients are morose and sullen. With mitral stenosis the patients are excitable and impulsive, discontented, querulous, and frequently have delusions as to ill-usage, or as to their food being poisoned. With aortic regurgitation there would appear to be associated restlessness and sleeplessness, together with misinterpretation of internal sensations, sometimes delusions of exaltation, and at times loquacity and general excitement. Aortic stenosis is sometimes attended by impulsiveness, violence. and delusions as to persecution and poison. When the aortic valve becomes atheromatous there is a tendency to rapid mental decay. When mitral and aortic diseases are associated there may be also a gross cerebral lesion, with dementia and degradation of the bodily functions generally. With hypertrophy and dilatation of the heart there may be depression or delusions as to persecution. Degeneration of the cardiac muscle is sometimes attended with irritability, restlessness, and ideas of persecution.

The relative frequency of the various forms of cardiac disease occurring in association with different mental manifestations is a subject of interest, but we are unable to explain the nature of the mental disturbance solely from the consideration of the cardiac disease. Were the cardiac disease the sole cause of the mental disorder, the wards of general hospitals ought to provide us with innumerable data upon which to base our conclusions. Since no one individual reacts to circumstances in precisely the same way as any other individual, it is impossible, without full consideration of the life-history, habits, and mental characteristics, to do more than conjecture as to the nature of the mental reaction which may occur in association with any bodily disease. From a clinical point of view we know that, in an insane person, vague ideas of fear, sleeplessness. and subacute forms of excitement, are commonly associated with cardiac disease.

The numerous investigations upon the character of the pulse in insanity have only taught us, that there may be low or high tension. and that the variations bear some relationship to the general physical condition of the patient. The blood has also been subjected to much analytical examination. We may say briefly, that it may or may not be deficient in quantity or quality according to the physical condition of the patient at the time of the examination. An excess of bile or uric acid may be associated with depression or irritability respectively; but the condition of the serum, fibrin, and globules bears no constant relationship to the mental state. Deterioration of the blood may be attended by any form of mental disease; or, conversely, mental disease may be associated with any form of blood deterioration. It is obvious, also, that poor blood is not necessarily associated with insanity. In general paralysis absence of rouleaux, and increase of the colourless blood-corpuscles at the expense of the red, have been noted, especially in the later stages; but similar conditions are found in other degenerative diseases, and do not necessarily, therefore, bear any obviously constant relationship to the mental symptoms. Hitherto, this line of research has not yielded much towards the solution of the main question—viz., the direct relation of the blood to the mind. The only conclusion at which we can arrive is, that in some instances blood-deterioration and mental diseases are associated, or possibly they are mutually causal factors; but, at the same time, it must be remembered, that each condition is relatively more frequent by itself than in association with the other.

Phthisis is regarded as bearing a fairly definite relationship to morbid mental states. Phthisical patients are liable to become insane, and, conversely, insane patients are liable to become phthisical. Beyond the characteristic hopefulness of phthisis, however, there is no definite or obvious clinical relationship. The irritability and the tendency to find grievances upon the slightest pretext are in no wise more commonly associated with phthisis than with other exhaustive diseases of the body. Idiots and imbeciles are particularly prone to become phthisical, and, according to Ireland, two-thirds of them die of it. Some authors believe, that there is a distinct form of phthisical insanity. This, however, is by no means satisfactorily established. Undoubtedly, mental diseases which are attended by bodily exhaustion and malnutrition predispose to the occurrence of phthisis. In such cases the mental symptoms obviously appear before the phthisis. Sometimes many of the symptoms of phthisis are absent when insanity is present, or the functional processes of the two diseases may alternate. On the physical side the symptoms are usually those of phthisis, and on the psychical side those commonly associated with exhaustive diseases. Other diseases of the respiratory system may cause such exhaustion of the bodily functions that insanity supervenes, or *vice versâ;* or the symptoms, bodily and mental, may alternate.

*Febrile Affections.**—The occurrence of insanity as a complication of, or as a sequel to, acute febrile disease has long been noted. The mental disorder may occur as the earliest symptom, but more commonly it appears during a later stage of the fever, especially during the period of convalescence. The intensity of the fever bears no constant relation in the production of insanity. Nasse classified the mental affections originating in fever according as they are the immediate result of the fever itself, as they constitute a prolongation of the delirium when the fever has subsided, or as they arise during convalescence. The specific infectious fevers, intermittent fevers, and long agues are apt to be followed by insanity. Erysipelas, articular rheumatism, acute angina, diphtheria, erythema nodosum, miliary roseola, purpura, febrile urticaria, guttural herpes, and other acute febrile diseases are also sometimes followed by insanity.

There does not seem to be any definite relation between the different forms of insanity and the nature of the febrile disease. One point of clinical interest to be noted is, that after typhoid, typhus, smallpox, scarlatina, cholera, diphtheria, influenza, or malaria there may be physical symptoms which, when associated with insanity, closely simulate general paralysis of the insane. The general constitutional disturbances and degeneration of the tissues of the body (especially of the cerebrospinal system), which occur in pellagra, are frequently attended by morbid mental states. These mental states, however, have nothing unusual or characteristic in their nature to distinguish them from those of other exhaustive diseases. Influenza has frequently proved itself to be a determining cause of insanity, and this more readily in individuals who are predisposed to neurosis.

* Hyslop, "Dict. of Psych. Med.," p. 985.

Syphilis may or may not cause insanity. Some individuals may have syphilophobia as a symptom without any actual syphilitic affection. Others may have contracted syphilis and break down mentally in consequence of dread of the results. Savage* describes the following relationships between syphilis and morbid mental states:—(1) Insane dread of syphilis; (2) insane dread of results of syphilis; (3) syphilitic fever, delirium, and mania; (4) acute syphilis leading to mental decay; (5) syphilitic cachexia and dyscrasia, and mental disorder; (6) syphilitic neuritis (optic), with suspicion, or mania; (7) syphilitic ulceration, disfigurement, and morbid self-consciousness; (8) congenital syphilis, cranial, sensory, or nerve-tissue defects; (9) congenital syphilis, with epilepsy, or idiocy: (10) infantile syphilis may be acquired. (11) Constitutional syphilis (*a*) vascular or fibrous; (*b*) epilepsy; (*c*) hemiplegia; (*d*) local palsies; (*e*) general paralysis, cerebral, spinal (spastic and tabetic), peripheral. (12) Locomotor ataxy (*a*) with insane crisis, (*b*) with insane interpretation of the ordinary symptoms.

That syphilitic affections of the nervous system may cause insanity is a statement which requires no justification. There is much difference of opinion, however, as to the part played by syphilis in the production of general paralysis. Our experience in Bethlem leads us to believe, that more than half the general paralytics admitted to the hospital owe their disease to syphilitic factors. Savage believes, that at least seventy per cent. of his private cases of general paralysis have clear histories of constitutional syphilis. Clinically, we have also to note that syphilis sometimes gives rise to a pseudo-general paralysis in which, during the early stages, the symptoms may be identical with those of general paralysis; but subsequently there is an arrest or protraction of the symptoms in the pseudo-form, so that the patient may live for many years.

The syphilitic disease may manifest itself in lesions of the bones of the cranium, the membranes, blood-vessels, brain-substance, cerebral nerves, or of the organs of special sense. The skull bones may be absorbed owing to gummatous infiltrations, or small areas of caries with exfoliation may occur. The dura mater and the pia arachnoid may be thickened and

* "Tuke's Dictionary," p. 1253.

affected by various inflammatory deposits, or there may be gummata. The middle and inner coats of the arteries may show the characteristic endarteritis. Peri-arteritis and inflammatory deposits round the smaller arteries also occur. The brain-substance may be affected by means of an extension of the disease from the membranes, or as the result of deficient blood-supply. The nerve-structures of the cortex are apt to degenerate in proportion to the amount of overgrowth of the neuroglia substance. The cerebral nerves and the organs of special sense may be implicated symmetrically or otherwise. The nerve-fibres may become atrophied and fail to perform their functions.

Diseases of the nervous system may be the predisposing or exciting factors of an attack of insanity. *Epilepsy* may depend upon general nervous instability, and this in turn may be due to cerebral lesions. It is important to remember that injury or disease which leads to insanity in one individual may lead to epilepsy in another. In neurotic families it is not uncommon to find one child epileptic and another insane. The children of neurotic parents are particularly liable to suffer from convulsions which may become epileptic in character, and when habitual, the mental development is apt to be arrested. Morbid mental symptoms may precede or follow an epileptic fit. When they precede the fit they may be in the form of sensory perversions (illusions or hallucinations), delusions, or maniacal outbreaks: when they follow the fit they may appear as confusion, melancholia, irritability, suspicion, hallucinations, false accusation, moral perversion, and, not uncommonly, mania, or epileptic furor, with suicidal or homicidal impulses. When there is imperfect loss of consciousness with automatic action, the condition is termed *masked epilepsy.* The patient does not fall down, and in some cases actions are performed automatically. Sometimes violent emotion, with violent or vicious acts, take the place of the automatic act. *Jacksonian epileptic* attacks differ from ordinary epileptic attacks in that the spasm progresses in a definite direction. Consciousness may be lost late in the paroxysm, and temporary paralysis or aphasia may follow the seizures. This variety is mostly due to cortical irritative or degenerative lesions.

Epilepsy includes all paroxysmal sensori-motor discharging lesions of the nervous system. The affection may involve any or all parts of the cerebro-spinal system—*i.e.*, the "lowest, middle, or highest levels" of Hughlings-Jackson. Nutritive molecular changes in parts of the nervous system are apt to cause discharging lesions, which necessarily vary according to the importance and complexity of the functional provinces involved. Discharging lesions involving the highest centres throw the organ of the mind more or less out of gear. In the severe forms of epilepsy the discharging lesion may begin in the cerebral cortex and extend to the lower levels of evolution. In minor epilepsies, on the other hand, some part or parts of the anatomical substratum of thought, may alone be affected, so that the temporary defects of consciousness are the sole manifestations. The analogy between what happens in epilepsy and in maniacal and uncontrolled mentation is thought by some authors to be well-nigh complete. They assume, that in both conditions the mental symptoms are due to excessive cerebration. Of this view we shall, however, have to speak again, so we now return to the consideration of other neuroses which may be factors in the causation of insanity.

Hysteria has its physical basis in an (apparently) functional disorder of any or all parts of the cerebro-spinal system. The symptoms vary according to the functional provinces mainly involved. The mental characteristics are usually manifested in paroxysms with or without uncontrollable physical symptoms. By some authors it is assumed, that hysteria is an affection of functional provinces which are often actually controllable by the influence of other and higher centres. This, however, is an hypothesis which is scarcely susceptible of verification. The bodily and mental causes which lead to hysteria may also lead to insanity; or insanity may supervene upon hysteria. There is no hard and fast line of demarcation between hysteria and mania: the one shades imperceptibly into the other. In both there may be sensory or motor disturbances with morbid perception and misinterpretation of their import.

Chorea is commonly attended by mental hebetude, inattention, loss of memory, and hallucinations of sight of an unpleasant nature. The mental symptoms may precede the actual choreic paroxysms. Choreic insanity may be of any type, and it exhibits nothing that is characteristic. It may appear in children, in pregnant women. or in old age.

Myxœdema is usually followed by insanity. During the earlier stages of the disease there is languor, indifference, and impaired memory. Sometimes there is irritability with hallucinations or delusions. The insane symptoms may be those of acute or chronic mania, melancholia with suspicion and self-accusation, or dementia. The insanity may be due either to morbid self-consciousness as to their changed appearance, or to the morbid state of the vaso-motor nerves which directly affect the cerebrum. Whitwell* has noted the occurrence of inflated globose and curiously distorted nuclei, vacuolated in almost every conceivable way, in the cells of the third and fourth layers of the cerebral cortex.

Exophthalmic goître is supposed to be closely allied to the neuroses. Sometimes lesions of the sympathetic ganglia have been observed. The pathology of the affection is at present undecided. It has been regarded in turn as a scrofulous dyscrasia, a neurosis of the sympathetic, a disease of psychical origin, and as a paralysis of the vaso-motor centres and cervical ganglia. The disease is not uncommonly associated with mental symptoms. It may occur in association with melancholia, acute mania, delusional insanity, and even general paralysis. The exophthalmic symptoms may occur synchronously with the mental attack, and they may return with each recurrence of the insanity. It is more frequent in women than in men. In one case admitted to Bethlem the mental symptoms arose in connection with the change in aspect of the patient: painful self-consciousness gradually changed to ideas of persecution. Another case began with exaltation and excitement: two others were first depressed, then melancholic, with refusal of food, impulsive violence, and dirty habits. Exophthalmic goître has been observed as occurring temporarily from sudden shock. Sometimes it is associated with epilepsy, paralytic affections, hemianæsthesia, or even with aphasia.

Spinal affections may precede, occur in connection with, be symptomatic of, or follow, various forms of mental disease.

* "Brit. Med. Journ.," Feb. 27, 1892.

Insanity without paralysis is not attended by spinal changes. Traumatisms, slow compressing lesions, cornual or columnar lesions, indiscriminate lesions, or functional defects of the spinal cord may be associated with insane symptoms of a temporary nature, or they may be associated with cerebral lesions and progressive mental deterioration.

To describe the various spinal diseases which may be associated with insanity would necessitate an account of all the extra and intra-medullary lesions dependent upon recognisable organic causes. and also of the various intrinsic or functional defects, such as the toxic spinal paralyses, intermittent, hysterical, ideational, and reflex paraplegias, etc. It must suffice for us to remember, that the spinal lesions may be primary or secondary to cerebral lesions. Beyond this general statement we cannot venture. There is no more definite relationship between system lesions of the spinal cord and insanity than there is between lesions of other systems and the mind. Every variety of spinal disease may occur in the insane, and every variety of spinal disease may occur without insanity. There are no special mental symptoms of spinal lesions, and there are no special spinal symptoms of mental diseases. In general paralysis we meet with nearly every variety of spinal degeneration, but there is no constancy in the relationship.

Affections of the sympathetic are but imperfectly understood. The intimate relationship between all parts of the cerebral cortex and the exquisite mutual dependence of the various parts of the nervous system—cerebral, spinal, and sympathetic—on each other, render this subject one of extreme intricacy and difficulty. The sympathetic system is undoubtedly affected in many morbid cerebral states. Whether the affection is developed as a reflex irritation, or whether the sympathetic system possesses a special pathology of its own and acts as a primary factor in determining the morbid cerebral state, we are unable to decide. The intimate relations existing between headache, insomnia, epilepsy, or other cerebral affections, and the regulation of the vascular tone through the sympathetic, lead one to suppose that possibly the sympathetic plays a very prominent part in the production of many changes of structure and lesions of nutrition in the cerebrum. It is generally believed, that the influence of the sympathetic is brought about secondarily by reflex irritation from some other organ in the body.

Cerebral affections have already been in part considered ; but in order to render the physiological part of our subject more complete it is necessary that we should briefly enumerate some of the causes of paralyses of encephalic origin. Among these causes we have to note, traumatisms, meningeal, cerebral and cerebellar hæmorrhages, occlusions of vessels by thrombosis or embolism, tumours of the brain and its meninges (*e.g.*, tubercle, scrofula, cancer, gliomata, sarcomata, myxomata, tumours of the pituitary body, and exostoses), abscesses within the cranium, meningo-encephalitis, disseminated sclerosis, aneurysms, hydatid cysts, cysticerci, simple cysts, and congenital or early infantile pathological states of the brain. The signs and symptoms of these various affections do not form part of our subject ; and as we have already discussed their value from the point of view of localisation of mental phenomena, we, therefore, now pass to the consideration of those intoxicants which act as factors in the production of mental diseases.

Intoxicants.—*Alcohol.*—The effects of alcohol upon the exquisite structures of the brain, and consequently upon the mental faculties which these structures subserve, have been so widely investigated that the subject need only be briefly referred to here. The derangements due to alcohol may be mainly sensory, motor, or intellectual. Alcohol may produce a temporary disturbance of the intellect by means of its direct poisoning influence on the brain, or it may cause structural alterations of the brain which are characterised by progressive weakening of the mental faculties and finally dementia. The symptoms of direct poisoning and slow decay of the brain and mind need not be dwelt upon.

Alcohol may be absorbed through the serous, mucous, or respiratory surfaces, and may leave the system unchanged. It produces changes in the blood which lead to profound nutritional disturbances in the brain and sympathetic system. The action of alcohol upon the cerebrum is so wide-spread and so variable that any mental symptom may appear. Bevan Lewis says, "The symptoms of implication of special cerebral territories too often dovetail and overlap for any trustworthy clinical classification to be adopted; and still more frequently if the history be one of progressive invasion of one territory after another. The more characteristic forms, however, under which cerebral alcoholism presents itself to our notice in asylums for the insane, are the following:—(1) Purely sensorial type—(*a*) common sensibility; (*b*) visceral; (*c*) special. (2) Primary amnesic forms. (3) Premature senility, especially implicating motor areas of cortex. (4) Delusional forms with vascular lesions in basal ganglia and medullated tracts of the cerebrum. (5) Motorial types."

Andriezen* believes, that while cases of the extensive and generalised type of alcoholic insanity are by no means rare, the majority of the alcoholic insane are those who belong to the other class in which the main morbid stress and evolution of the symptoms develop in this or that "intensive and specialised way." He also believes, that changes occur in the anatomico-physiological connections between the neurons. "Change of a very striking and unmistakable character occurs in the ultimate protoplasmic expansions and 'contact-granules' situated upon them on the one hand, and in the ultimate naked fibrils (collaterals and terminals) which everywhere come into relation with such protoplasmic termini and granules on the other. Beginning with a softening and swelling of these contact granules, and also of the protoplasmic twigs on which they are situated, the earliest noticeable changes are a coalescence of these into small irregular 'composites' of such, recognisable here and there as a local coarseness. As the changes progress in coarseness and extent, they can now be more easily recognised as commencing moniliform swellings along the course of the terminal protoplasmic twigs." These early dynamical changes in the field of conjunction are held to represent, on the psychical side, the diminished capacity of the neurons to be excitable to presentative sensorial stimulations; the diminished permeability in the pathways of nerve-currents issuing from one neuron by its nervous processes and its terminals to another neuron in the cortical area, having its

* "Brain," p. 666, 1894.

psychical counterpart a slowness in the arousing of associated images, and delay of reaction time.

These observations are of great interest to cerebral pathology, and did the associated mental symptoms present any uniformity they would be valuable to mental physiology. It is more particularly in the early stages of alcoholism that all kinds of mental manifestations are possible, and swellings of the "contact granules" may serve to explain delay in the passage of nerve-currents, and therefore also delay in the physiological manifestations; but these swellings afford us no explanation as to the origin of the hallucinations or the delusions so commonly met with in the alcoholic insane. They may possibly serve to throw some light upon the amnesic defects as manifested in the slowness in arousing associated images, but they do not account for the positive mental affections which are characterised by emotional or intellectual perversions. Lesions of the spinal cord may serve to delay sensation or reflex action, and the description of such lesions might suffice to account for the delay. Such a description, however, would furnish us with no explanation of the ultimate physiological factors associated with the mentation. Similarly, lesions of the "fields of conjunction" in the cortex afford us no ultimate data for the explanation of morbid psychical manifestations. Here, as in other instances, we must have recourse to physiological hypothesis as to the ultimate material elements concerned with mind, and by so doing we can only speculate about the unknown and unknowable. The most that pathology has done in this instance is to partly verify the opinion as to the coexistence in time between the events, the physical and mental series.

Lead poisoning is not infrequently attended by symptoms which somewhat resemble those of general paralysis. Saturnine cases may exhibit symptoms of mania, melancholia, dementia, or pseudo-general paralysis. Regis notes the frequency of nightmares, terrifying hallucinations, and ideas of persecution with, also, very marked tremor of the limbs. The pseudo-general paralytic symptoms generally appear after the delirious symptoms of the lead intoxication have passed off. Under appropriate treatment the disease proves itself to be essentially curable. The presence of neuralgic pains, convulsions, cramps, headache, delirium, stupor, amaurosis, paralysis of the extensor muscles of the wrist, anæsthesia of the affected part, fatty degeneration of the muscles, and the other special symptoms of lead poisoning render a diagnosis possible. The lead appears to act primarily on the muscles, then on the nerves, and lastly on the nerve-centres.

Morphinomania resembles in its effects the symptoms of the other toxic insanities. The abuse of morphia is usually attended by well-known mental and physical perversions, which sooner or later become symptomatic of cerebral degeneration. Sudden withdrawal of the drug is also apt to be attended by a characteristic train of symptoms which may range from mere irritability to maniacal delirium. The fact that morphia produces an exaltation of the mental faculties, a greater brilliancy of the imagination, and an aptitude for study, has proved itself to be the cause of the mental ruin of no few individuals.

Other toxic agents, such as belladonna, hyoscyamus, stramonium, absinth, ether, chloroform, chloral, cocaine, haschisch, nicotine, etc., when taken in large quantities are apt to cause cerebral disorders and various psychical symptoms, but space will not allow of their consideration.

Immediate Factors.—Hitherto we have devoted our attention to the consideration of bodily factors which act upon the brain either directly or indirectly; it now remains for us to refer to some of the more immediate brain factors themselves. The mechanism of cortical functional hyperæmia is, as we have already seen, only imperfectly determined, and we do not as yet know how functional hyperæmia is immediately brought about. The theory, that the special functional activities concerned with mental events are attended by a special functional hyperæmia is supported upon the crudest and most slender grounds. We are told that the cortex of a man's brain bulges through a hole in his skull when a mental stimulus is applied,* and that with the occurrence of activities within definite brain-areas there is, or ought to be, a sudden rapid change of blood-supply to those areas.†

* "Pathology"—"Tuke's Dictionary," p. 896.

† Meynert, "Psychiatry," p. 214.

Let us for a moment consider these suppositions a little more closely. It is assumed, that in the ordinary course of psychical events the immediate substratum of physical activity rests somewhere within one or more of the exceedingly minute cortical cells, or in the ramifications of its processes. If now we take for illustration an "idea"—which presumably derives its component parts through association paths from several areas—it seems reasonable to assume, that with the activities within these different areas there is a corresponding functional hyperæmia. This necessitates a rapid change of circulation in several areas at once.

In fact, if the theory is to be complete, the hyperæmia must follow the mind through all its variations. This may be the case for all we know to the contrary; but it is scarcely credible that any psychical act taking place, presumably within a structure so minute as a nerve-fibril, should also determine a hyperæmia which would make the cortex of the brain bulge through a hole in the skull. Undoubtedly, the vascular supply of the brain is arranged so as to favour the rapid production of hyperæmia; but surely the extreme rapidity of thought is not entirely and immediately dependent upon a mechanism which lumbers along in its wake, causing here and there a turgescence or bulging of the whole structures? That the finely molecular activities of the nerve-substance require such a vastly disproportionate blood-supply is scarcely credible. Such a relationship between the visible hyperæmia and the molecular activity would appear to be proportionate to the relationship between an Atlantic wave and the activities in coccoliths and coccospheres embedded in the Bathybius of the sea-bottom.

Interference with the nutrition of the nervous tissues, if long continued, is followed by a series of changes in those tissues. In idiopathic brain disorders there is supposed to be primarily an abnormal supply of blood to the brain. This may pass on to a sub-inflammatory condition, in which more leucocytes are deposited than in the normal state between the adventitia and muscular coat, or there may be proliferation of the connective tissue cells of the vessel. Should these leucocytes and connective tissue cells break down, the *débris* occupies the perivascular spaces, and thereby implicates the lymphatic circulation. Retention of the waste products tends to affect the functional integrity of the nerve-cells and of their processes and fibres. The actual degeneration of the cell protoplasm is supposed to be due to toxic action from within and deprivation of proper nutriment from without.

The pathological appearances of inflammatory action in the skull, membranes, and blood-vessels are fully described by Bevan Lewis, Batty Tuke, Sims Woodhead, and others. The neuroglia and connective tissue cells have also been very carefully described by these authors. Finally, the numerous and elaborate investigations upon the pathology of the nerve-cells have furnished us with so much valuable material that a mere dilettante consideration of them would only prove unsatisfactory to the student, and hardly do justice to the importance of the subject.

We propose, therefore, merely to consider the factors of the insanities in so far as they are dissolutions, or reversals of evolution. To Hughlings-Jackson* we are indebted for a forcible conception as to the pathogenesis of maladies of the nervous system. He assumes, that in every insanity there is morbid affection of more or less of the highest cerebral centres, or, synonymously, of the highest level of evolution of the cerebral sub-system, or, again synonymously, of the anatomical substrata or physical basis of consciousness. There may be discoverable disease destructive of nervous elements, or there may be loss of function from some undiscovered pathological process inferred from symptoms. In every insanity more or less of the highest cerebral mechanism is out of function, temporarily or permanently, from some pathological process whatever it may be. In studying the insanities as dissolutions we have to take into account not only the depths of dissolution of the highest cerebral centres, but also the evolution going on in the undamaged remainder of them—the mentation remaining possible when various centres have been mutilated in different degrees.

* "Factors of the Insanities"—"Medical Press and Circular," Dec. 9, 1874; *ibid.*, Aug. 30, 1893; *ibid.*, June 13, 1894; "Transactions Ophthalmic Soc.," vol. vi.

In every form of insanity (dementia excepted) there is a double symptomatic condition—viz., a negative and a positive condition. The negative is due to disease (negative lesion); whilst the positive is the outcome of activities of the healthy structures remaining. Disease, therefore, only causes the physical condition corresponding to the negative mental element. The positive symptoms vary inversely with the depth or extent of the negative lesion. For illustration, Hughlings-Jackson takes the case of a general paralytic who believes he is Emperor of Europe. "The delusion arises during activity of perfectly healthy nervous arrangements, presumably those of the posterior lobes and those left intact of the anterior." The disease of the anterior lobes he regards as responsible for the patient's not knowing that he is X.Y., a clerk in the city. This illustration we believe to be unfortunate, inasmuch as general paralytics at one moment may state that they are kings or emperors, but at the same time they do practically recognise that they are X.Y. Similarly, general paralytics construct schemes for the distribution of fabulous wealth, but immediately afterwards beg for tobacco, and tell you, with perfect accuracy, that they possess only a few pounds sterling, or that they are bankrupt. Moreover, they almost invariably answer to their names (especially during the early stages), and make a sharp distinction between their real and ideal existence. This, however, does not really interfere with the validity of the hypothesis.

Illusions, delusions, extravagant conduct, and abnormal emotional states in an insane person may signify evolution, and not dissolution. The positive mental states are held to *imply* the coexistence of negative mental states, defective perception, less reasoning power, less adaptation to present surroundings, and absence of the finest emotions. The examples given are, (*a*) any illusion implies, that a thing is *not* recognised as it would have been before the insanity, and this means, that there is a coexisting negative element; (*b*) any delusion implies, that the patient does *not* believe as he would have done before he underwent dissolution, and this means, that there is a coexisting negative mental element.

Whilst admitting the difficulties in demonstrating the physical nature of the negative lesions, we agree with Conolly, who defined insanity from the psychical standpoint as "an impairment of one or more of the faculties of the mind, accompanied with, or inducing, a defect in the comparing faculty." The psychical elements of the comparing faculty are derived from experience. Hence, the negative lesion would in reality consist in the deprivation of the individual of some part of his experience, and this (from the negative point of view) would mean merely a defective or perverted memory. The negative lesion would, therefore, imply an interference with the material residues of experience. But this alone does not explain the nature of the positive symptoms. In popular language, the fact, that one batsman "retires hurt" from the cricket field, does not necessitate "tall" scoring of the undamaged remainder. Similarly with the general paralytic, the existence of a negative lesion does not account for the exaltation of his ideas and his delusions of grandeur. Undoubtedly, the exaltation and the delusions are the work of the undamaged remainder, but this is no explanation of how they originate.

In conclusion, we may state, that hitherto brain pathology has only served to demonstrate, (1) that part or parts of the complex process of our mental experience may be, by the existence of negative lesions, rendered inert or incapable of revival in consciousness. (2) That mental and physical phenomena do bear time relationship to each other; perversions of the latter are in some cases attended by altered mental time reactions (as compared with normal psychical reactions). (3) We have no *physiological* data which give the faintest solution to the problem as to *how* the positive activities of the mind, both normal and morbid, come to exhibit such endless diversities and infinitely varied relations.

APPENDIX A.

HYPNOTISM.

THE phenomena of hypnosis, in spite of having been subjected to scientific treatment, are still very obscure. The observed facts in cases of hypnosis consist of various physiological and psychological manifestations which are regarded as causally connected with each other. Before entering, however, upon any question of their causal relations, it is necessary that we should briefly review some of the more important facts observed on the physical and mental sides respectively.

Mesmer (1734) first studied artificially-induced sleep. He attributed the effects to the action of the heavenly bodies, and "animal magnetism" was regarded as the special agency of the phenomena. Deleuze (1825) believed, that a magnetic influence (magnetic fluid) belonging to the vital principle passed from one person to another. Braid (1842) first attributed the phenomena to the laws of nerve-action. Since then, Charcot, Luys, Doumontpallier, Binet, Féré, Liébeault, Bernheim, Forel, Moll, Dessoir, Sperling, Preyer, Baierlacher, Tuke, Bramwell, and others have contributed many observations which throw some light upon the subject.

Methods of inducing hypnotic sleep.—(1) Braid made the subject fix his eyes on a bright object placed a little above the eyes opposite the middle line of the forehead, so that visual fatigue quickly followed, the eyes being directed in convergent strabismus. (2) Lasègue pressed lightly upon the eyeballs with his fingers. (3) Pitres pressed upon special regions of the body *(zones hypnogènes).* (4) Monotonous sensory impressions produced by passes, etc., will induce the hypnotic state.

(5) By the psychological principle of suggestion. (6) By combinations of any of these methods.

Operators vary in their power of inducing hypnotic sleep. Subjects also vary in the extent to which they can be hypnotised. Children under three or four years of age are difficult to hypnotise. The power of attention, of concentrating the consciousness upon the matter in question, renders a person more susceptible to hypnotism. Hysterical individuals are readily hypnotised. Idiots and imbeciles are unusually hard to hypnotise. Similarly, insane persons are often difficult to affect in this way. Hitherto we have had (in England) little success in hypnotising insane patients. The English race does not appear to be very susceptible to hypnotic suggestion. Robertson* tried to induce hypnotic sleep in some insane patients at Morningside Asylum, and he met with a certain amount of success. Our experience at Bethlem, however, has not proved so satisfactory. Drs.Percy Smith † and A. T. Myers found, that of twenty-one cases in which hypnotic suggestion was tried, only two were certainly hypnotised. In one case, however, the suggestions made were not acted upon; and in the other, although suggestions seemed at first to be in a very small degree successful, the effect, instead of increasing, diminished rather rapidly. Where any improvement was noticeable in the other cases, the results gained were attributable more to the large amount of personal attention devoted to each case than to any hypnotic influence.

In order to awaken the subjects, it is customary to blow on their eyelids, or to rouse them in some vigorous manner.

Symptoms of the hypnotic state.—The different phenomena have been divided by Charcot, and with the approval of Richer, Tamburini, and Seppili, into three fundamental types--the *cataleptic*, the *lethargic*, and the *somnambulistic*. In the *cataleptic* state the limbs retain the positions in which they are placed for a considerable time, and without effort. In the *lethargic* state the subject is insensible to the most painful stimuli; the muscles which are relaxed are found to possess the power of contracting in a definite way under gentle

* "Journ. Ment. Science," Jan. 1893.

† *Ibid.*, April, 1890.

mechanical applications. His intelligence seems to be abolished, and he does not respond to questions or react to suggestions, although he may realise them when he awakes. The phenomenon of neuro-muscular hyper-excitability proves itself to be the most interesting feature of the lethargic state. Charcot has demonstrated, that if in the subjects of *la grande hysterie* one compresses a superficial nerve, there follows a contraction of the muscle it supplies. This contraction is sometimes very intense; the muscles become rigid and stiff, and would be torn sooner than bend. In order to cause this rigidity to disappear, pressure is made upon the antagonistic muscles of the contracted ones.* The *somnambulistic* state can be induced by rubbing the vertex of a person in the lethargic state. The explanation of this is unknown. The remarkable neuro-muscular excitability is retained, but in a somewhat transformed state. According to Charcot and Gilles de la Tourette, it is no longer by hard pressure or friction of the muscles or compressing the nerves that it is brought about; it is, on the contrary, a simple, superficial, purely cutaneous stimulation which makes the underlying muscles contract. These observers state, that lightly pressing anything over the skin—the movement of the stratum of surrounding air—is sufficient to produce this effect.

The *mental condition during hypnosis* is very varied. Subjectively considered, the experiences as to sensation, conception, memory, and volition are of great interest. In previous pages we have discussed the relationship of hypnosis to memory (p. 349) and to volition (p. 424); it now remains, therefore, for us to give a brief account of sensations peculiar to it. Except in the early stages of hypnosis, there is usually insensitiveness to pain. At the suggestion of the operator, however, it is possible to produce hyper-algesia. Ordinary tactile sensibility may remain unaffected. The sense of smell may be absent, so that strong ammonia or pepper produces no reaction; or there may be hyperæsthesia, and a vastly heightened sensibility of the olfactory nerve. Visual sensations are partially affected in the early stages: in the later states the sense of sight may become preternaturally acute. There may be anæsthesia or hyperæsthesia of the sense of hearing. Sometimes the subject

* "Hypnotism"—"Tuke's Dictionary," p. 608.

hears what is said to him by the operator and by no one else. Taste is generally suspended, or, by suggestion, the subject imagines various tastes.

Consciousness, objectively considered, may appear to be present and normal; or there may be an abnormal susceptibility to psychical impressions. In the deep stages of hypnotism, however, the mind is much more markedly obedient to the suggestions of the operator. Some individuals when hypnotised have the peculiar experience that they exist in duplicate. The one self is fully aware of what the other self is doing. This condition of duplicate consciousness is not uncommon in insane individuals. Hack Tuke* recorded the case of a patient several years ago in Bethlem Hospital, who, having lost himself —*i.e.*, the self he was most familiar with—used to seek for himself under the bed. Hack Tuke believed, that the explanation of this division of consciousness was to be sought in the relation between the two halves of the brain, or between different centres in the entire cortex. One patient now in Bethlem used to say that his body did not belong to him, and complained bitterly of the false position in which he was placed by an apparatus which was no part of himself. Such instances are not uncommon, but their physiological explanation is still a matter of conjecture.

Suggestion.—As we have already said, the susceptibility to outside suggestions is one of the most noticeable features of the hypnotic state. Some observers maintain, that the hypnotised subject is at the mercy of every suggestion, however absurd, and every crotchet, however wild and impractical. This, however, is not strictly true. The hypnotised subject is not necessarily always passive; or, as Charcot says, "the subject's credulity has its limits." Moreover, it has been found impossible to make a subject commit an actual crime. A state of ecstasy can be induced by suggestion. Hallucinations and delusions are readily induced, and they may persist for some time after the subject is awake.

Theories as to the hypnotic state: (1) Theory of *animal magnetism* is now almost entirely given up, or, at any rate, scarcely ever referred to. (2) Theory of *neurosis*. Charcot and

* "Sleep Walking and Hypnotism," p. 82.

his colleagues at the Salpétrière maintain, that hypnotism is a neurotic manifestation which has been evolved, in a vast majority of cases, on a soil prepared by hysteria, with which it has many points in common. They also believe, that "suggestion" is an important element, but that it is not more important than that which must be assigned to somatic phenomena. They argue, that although the psychical phenomena are susceptible of being stimulated, the same cannot be said of the physical ones which are completely independent of the will of the subject in the hypnotic state. (3) The theory of *suggestion* denies the neurosis theory. It assumes, that the bodily symptoms are the result of expectation and training. In proof of this we have the fact, that all the neurotic manifestations may be induced by suggestion. Many of the physical symptoms are due to the methods employed at the Salpétrière. Simple verbal suggestion, as employed at Nancy, is but seldom attended by any of the classical lethargic, cataleptic, or somnambulistic states, except when induced by the influence of the operator.

Although the theory of suggestion has at the present day the greatest number of supporters, we must not forget that the psychical factor "suggestion" does not explain the occurrence of the extraordinary bodily states, or of the subject's increased susceptibility to the suggestions. We agree with Ladd,* that the principle of suggestion is definitely a *psychological* principle, and nothing else; but we cannot say, that the psychological principle of suggestion is explanatory of any of the physical manifestations. The phenomena of the hypnotic state are both bodily and mental. No psychological principle can account for any physical state, and no bodily state can account for the psychical phenomena. The suggestion theory is regarded as satisfactory when it refers to psychical phenomena, although even there it does not explain the increased susceptibility to suggestion. Or, as Professor James † justly remarks, "the suggestion-theory may therefore be approved as correct, provided we grant the trance-state as its pre-requisite. The three states of Charcot, the strange reflexes of Heidenhain, and all

* "Philosophy of Mind," p. 277.

† "Principles of Psychology," vol. ii. p. 601.

the other bodily phenomena which have been called direct consequences of the trance-state itself, are not such. They are products of suggestion, the trance-state having no particular outward symptoms of its own; but without the trance-state there, those particular suggestions could never have been successfully made."

Post-hypnotic suggestions are those suggestions given to a subject during the hypnotic state with the intention of making the effects last in the waking state. The therapeutic bearings of hypnotism are manifold. Among the sane, the condition has been utilised to correct morbid habits and cravings. Some individuals have acquired considerable talent in special directions by the aid of hypnotism. Thus, one person who suffered from nervousness and a certain amount of hesitancy in his speech was enabled to overcome both defects by post-hypnotic suggestion. He now displays considerable talent as a public speaker.

Among the insane, it has been employed, as a sleep producer, as a sedative in excitement, to dispel fleeting delusional states and the minor psychoses, to overcome morbid resistance of patients, and as a substitute for mechanical restraint.*

* Robertson, "Journ. Ment. Science," p. 11, 1893.

APPENDIX B.

PSYCHO-PHYSICS.

Experimental psychology has as its aim the investigation of the general laws with regard to the relation of processes of stimulation and sensation: it also includes the consideration of the processes which intervene between stimulation on the one hand and the complex processes of mental action on the other.

In practical psycho-physics attention has been more particularly directed to the questions of absolute and comparative sensibility. The methods whereby stimuli are measured in relation to sense-impressions are, according to Fechner*:—(1) The method of *ascertaining differences of sensation which are just distinguishable.* This may be done—*e.g.*, by comparing the difference between two weights: if the difference be great, it is easily distinguished; if not great enough, it will with difficulty be distinguished, or perhaps not at all. The method consists in finding that difference which just becomes appreciable, and this difference is reciprocal to the sensibility—*i.e.*, if the appreciable difference is great, the sensibility is small, and *vice versâ.* (2) The method of *right and wrong cases.* This consists in testing the sensibility—*e.g.*, by weights or light, constantly varying the amount of the former and the intensity of the latter. Cases in which the difference is correctly appreciated are called "right cases"; those in which it is not recognised or appreciated are called "wrong cases." From these results is ascertained the mean difference, which, as before, is reciprocal to the sensibility. The method yields very good results, but a considerable number of observations

* "Elemente der Psychophysik," 1889.

must be made. (3) The method of *ascertaining the mean error.* It consists—*e.g.*, in trying to find from a number of weights one which is equal to a given weight previously determined, or to draw a line equal to a given line. The difference between the actual weight or line, and those erroneously chosen or drawn by the person making the experiment, as being equal to the former, serves to determine the mean error, which again is reciprocal to the sensibility.*

Mental operations are regarded as measurable quantitatively as to their degree, duration, and number. By *degree* is meant the intensity, vividness, and, according to some authors, the distinctness of the impression or idea. (The amount of conscious effort—attention—involved is also taken into account.) By *duration* is meant the length of time involved in sensation, perception, ideation, sequences of ideas, memory, etc. The duration of mental operations is rendered susceptible to measurement by means of external arrangements. By *number* is meant the stages or steps involved in mental operations; or the estimation of the number of operations involved in a sequence of ideas or train of thought.

The various *psycho-physical lines of investigation* are as follows, after excluding all distractions:—(1) Test the discriminative sensibility of the skin with compasses, or by the æsthesiometer. (2) Test the sense of locality by touching different parts of the body. (3) Test the temperature sense as to the discrimination of differences at various regions. (4) Test the sensibility to heat and cold by applying metal points suitably warmed or cooled. (5) Test the discriminative power of motion by drawing a point up or down the skin of a limb, to determine whether the direction can be recognised. (6) Test the pressure sense by placing weights successively on the same spot, the patient to detect the difference between any pair of weights.

With regard to the senses of sight, hearing, taste, smell, etc., it is unnecessary to repeat the enumeration of the various data which have to be determined. Enough has already been said in regard to them when we discussed sensations and their perversions.

* See also Wundt, "Grundzüge der Physiologischen Psychologie"; and Müller, "Bibliothek für Wissenschaft und Litteratur," vol. xxiii.

Reaction time is the time which elapses between the application of a stimulus and a conscious reaction. The psychical process involves a greater length of time than does a simple reflex act. Reaction time is usually measured by causing the person experimented on to indicate by means of an electric signal the moment when the stimulus is applied. The reaction time is supposed to consist of the following events:—(1) The duration of the *perception*—*i.e.*, when we become conscious of the impression. (2) The duration of the time required to direct the attention to the impression—*i.e.*, the duration of *apperception*. And (3) the duration of the *voluntary impulse*, together with (4) the time required for conducting the impulse in the afferent nerves to the centre; and (5) the time for the impulse to travel outwards in the motor nerves.*

There is much difference of opinion as to the mental processes involved in reaction time experiments. The apperception process is now generally regarded as equivalent to the process of attention or of focussing the object. We do not agree with those observers who maintain, that the reaction of which the time is measured is practically a reflex action pure and simple, and not a psychic act. It is impossible to eliminate the psychic element from consideration, and its existence is most assuredly a pre-requisite. The facility of reaction will vary directly with the development of the cerebral mechanism; but, without the psychic pre-requisite what becomes of the reaction? The very nature of the experiment is dependent upon the existence of a will which is freed from all distractions. Expectant attention helps to facilitate the reflex action, but it does not form the only psychic element to be considered in reaction time experiments—*i.e.*, expectancy is a pre-requisite, and conscious volition is a requisite, in all time-reaction experiments. Expectant attention facilitates the process of conscious guidance; it does not determine the actual activity itself.

The instruments employed to test reaction time are:—(1) The "Bowditch Neuromœbimeter," or "nerve-reply measurer," which has been employed by Warren.† (2) The "Hipp Chrononoscope,"

* Landois and Stirling, "Text Book of Human Physiology," 3rd edit. p. 685.

† "Journ. of Physiology," vol. viii., 1887.

which is recommended by Jastrow.* (3) The "A-form Chronoscope" introduced by Galton.† (4) Marey's Chronograph has also been used.‡

In order to measure the simple reaction time with tactile, auditory, and visual sensations, the discrimination time, and the choice or volition time, Waller § uses a clockwork and cylinder covered with smoked paper, a chronograph, and Marey's tympana. The reaction times are taken, according to Waller's methods, as follows:—

To measure the simple reaction time with tactile, auditory, and visual sensations.—

Tactile.—The subject, blindfolded, places a finger on a lever. The operator taps the finger. The subject responds by pressing the lever as soon as he feels the tap. The interval between the two marks on the smoked cylinder gives the measure of the reaction time to a tactile stimulus.

Auditory.—The subject, blindfolded, places his hand ready to press the lever. The operator strikes the lever so as to make a sharp sound. The subject responds by pressing the lever as soon as he hears the sound. Reaction time as before.

Visual.—(The butt-end of the lever is painted white, the rest of the apparatus and the movements of the operator are hidden by a screen.) The lever is depressed quickly and quietly. The subject responds as soon as he sees the white end move down. Reaction time as before.

Take an average of the observations in each case.

To measure the discrimination time.—A double lever is now used.

Tactile.—The subject, blindfolded, places the index-finger of each hand on each lever, it being agreed that he is to react only to a touch on one side; sometimes one, sometimes the other, finger is tapped by the operator. Take the average of ten responses made in succession without mistake.

Auditory.—A single lever is struck, now with a small bell, now with a bit of wood. The subject, blindfolded, has to answer only to one or other of these two sounds. Take average as before.

Visual.—(The butt-ends of the two levers are painted of different colours.) The subject has to signal the movement of one or other of them as agreed upon. Average as before.

The result = simple reaction time.
+ discrimination time.

To measure the volition time.—

Repeat the previous series of observations, but with the understand-

* "American Journ. of Psychology," Dec., 1891.

† "Journ. of the Anthropol. Institute," Aug., 1889.

‡ Cf. "La Méthode graphique," part ii., chap. II.

§ "Tuke's Dictionary," p. 1021.

ing that the left-hand is to be used to signal touch, sound, or sight in connection with the left-hand lever, and the right-hand for differing stimuli of these three kinds in connection with the right-hand lever. Average to be taken as before.

The result = simple reaction time.
+ discrimination time.
+ choice or volition time.

Reaction time in the sane.—According to Jastrow,* the influences affecting reaction time may be (*a*) *objective*, or affecting the condition of the experiment; and (*b*) *subjective*, or affecting the attitude of the reactor. The objective influences are due to the nature of the impression, the intensity of the stimulus, and the mode of reaction required. The subjective influences are derived from the subject's foreknowledge of the experiment, the effects of distraction, the direction of the attention, practice and fatigue, individual variations, and variations under abnormal conditions. The influences affecting complex reactions are merely extensions of those already named.

Reaction time in the insane.—According to Bevan Lewis, in the earlier stages of *general paralysis* the reaction time to visual stimuli is uniformly delayed, and later on both visual and acoustic stimuli show a retardation in the response. In *chronic alcoholic insanity* there is delay in reaction time for both acoustic and optic stimuli. In *epileptic insanity* there is also delay which tends to exceed the retardation in either general paralysis or in chronic alcoholic insanity. Bevan Lewis says, "It will be apparent, from the observations on *healthy subjects*, that, whereas from twelve-hundredths to eighteen-hundredths of a second formed the limit of variability for *acoustic stimuli*, and fifteen-hundredths to twenty-two hundredths for visual stimuli, in the *insane* the former is only exceptionally below twenty-hundredths, and the latter rises from twenty-four-hundredths to thirty-hundredths of a second.†

The fundamental outcome of these time-reaction experiments would appear to be, that some people react more readily than others, and that bodily or mental perversions may further or retard the reaction. The practical value of such investigations will doubtless be proved in future.

* "Tuke's Dictionary," p. 1068.

† "Text Book of Mental Diseases," 1889, p. 136.

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